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THE ROSS RIFLE AND ITS MANUFACTURE*—1

A RIFLE HAVING A STRAIGHT-PULL BOLT ACTION WHICH WILL RESIST 100,000 POUNDS BREECH PRESSURE

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THE time is not yet at hand when the nations of this world "shall beat their swords into plowshares and their spears into pruning-hooks," but rather they are endeavoring to develop more wonderful and more powerful weapons than ever before. The ultimate outcome of this competitive endeavor is unknown to us, but laying aside the question of disarmament and considering the improvements in mechanical construction of the modern firearms, we will find much to interest us in regard to interchangeable manufacture.

The Ross rifle is a good example of the improvements made in the modern firearm. This rifle embodies much that is interesting in the way of mechanical movements. The designer and manufacturer—Sir Charles Ross, Bart.—as a large land owner in Scotland, has had ample opportunity of testing its capabilities. This, coupled with his experience in matters pertaining to the science of military rifle design and construction, has enabled him to produce a rifle of extraordinary velocity and accuracy. This rifle is of comparatively recent design, and was accepted by the Canadian government in 1901 for use by the militia. Previous to its adoption by the Canadian government all improvable points were exposed in the various debates which took place in the Dominion House of Commons. It was also tested by a committee of experts,

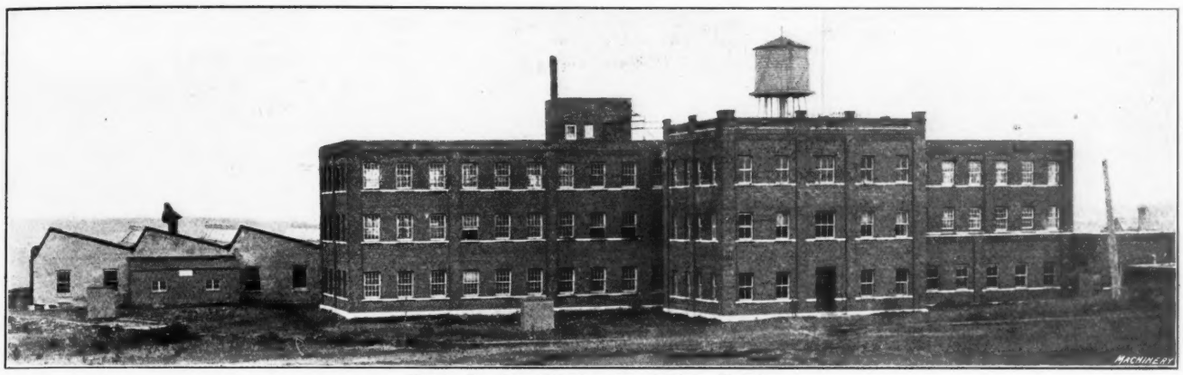

Fig. 1. The Ross Rifle Factory, Quebec, Canada

Fig. 2. Various Types of Rifles manufactured by the Ross Rifle Co.

* For additional information on firearms and kindred subjects previously published in MACHINERY, see "Cartridge Making—I," March, 1911, and other articles there referred to. See also "The Manufacture of Colt's Automatic Army Pistol," May, 1906, engineering edition; "The New Springfield Adopted by the United States Government," October, 1903, engineering edition.

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the tests being similar to those of the U. S. Ordnance Board, with every additional rigor of detail that ingenuity could devise. The rifle passed every test satisfactorily, and it now stands on its merits alone. The careful attention given to details and the ability of the designer of this rifle to take advantage of the peculiarities of its construction will be clearly set forth in the articles which will follow, dealing with its manufacture.

The Ross Rifle Factory

The Ross rifle is manufactured in the city of Quebec, the factory being located on the historic Plains of Abraham overlooking the St. Lawrence River. It is a three-story 200 by 45-foot brick building with two wings, each 60 by 45 feet. The boiler house is a separate building, 60 by 50 feet, and contains, besides the boiler for heating the plant, the case-hardening furnaces, hardening ovens and the blacksmith's forge. A 100,000-gallon water tank, erected on top of an old Martello tower, located at the rear of the factory, supplies water to the automatic fire sprinkler system located throughout the works. The various departments are run by separate motors, so that one department can be stopped independently of the others.

As is the usual practice, this factory is divided into departments, each one being used for some series of operations on the rifle. The front wing of the building is used exclusively for offices, while the lower one-story building, shown in the immediate foreground to the right of Fig. 1, is used by the government for inspection purposes. All manufactured parts, as well as the completed rifles, are inspected here by government inspectors, so that any rifles or parts that pass inspection can be relied upon as complying with the specifications. The lower floor of the main building, to the right, is devoted to the manufacture of the barrel; here the barrel-turning drilling and rifling machines are located. The second floor is occupied by the tool-room where all special tools, jigs and fixtures used in the manufacture of the rifle are made. The top floor is equipped with woodworking machinery for the manufacture of the stock. The lower floor of the main building, to the left, is occupied by the milling and profiling machines. The second floor is the screw-machine department and the top floor the assembling department. The rear wing of the factory is given up to stores, experimental, repairing, burring, buffing and finishing departments, and is equipped with machinery suitable for the purpose. All raw material, as well as the tool equipment consisting of milling fixtures, punches and dies, cutters, etc., is kept in the store-room. In the saw-tooth roof building to the left are the Ross rifle inspection and barrel straightening departments.

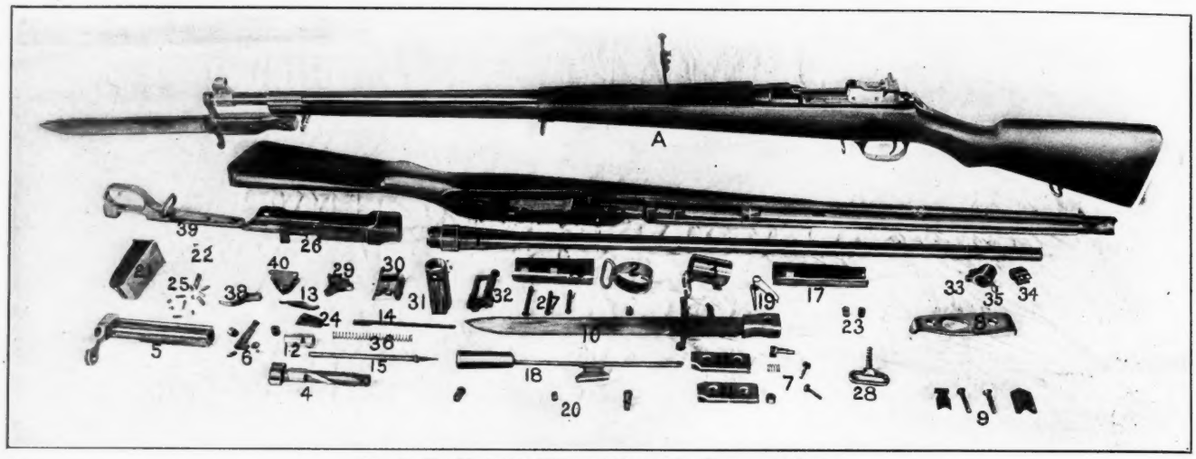


Fig. 3. The Mark II** Military Rifle and its Component Parts

Types of Rifles Manufactured

The first rifle manufactured by the Ross Rifle Co. was the military rifle, shown in its improved form at *A*, in Fig. 3 where the various parts are also shown. This rifle is called the "Mark II**," and is that used by the Canadian militia. The component parts of this rifle are listed in the following:

1. Barrel. 2. Band, rear. 3. Band, front. 4. Bolt. 5. Bolt sleeve. 6. Bolt, parts. 7. Bolt, locking parts. 8. Butt plate. 9. Butt trap plate, parts. 10. Bayonet. 11. Bayonet handles. 12. Cocking piece. 13. Ejector. 14. Extractor. 15. Firing pin. 16. Guard, rear hand. 17. Guard, front hand. 18. Lifter.

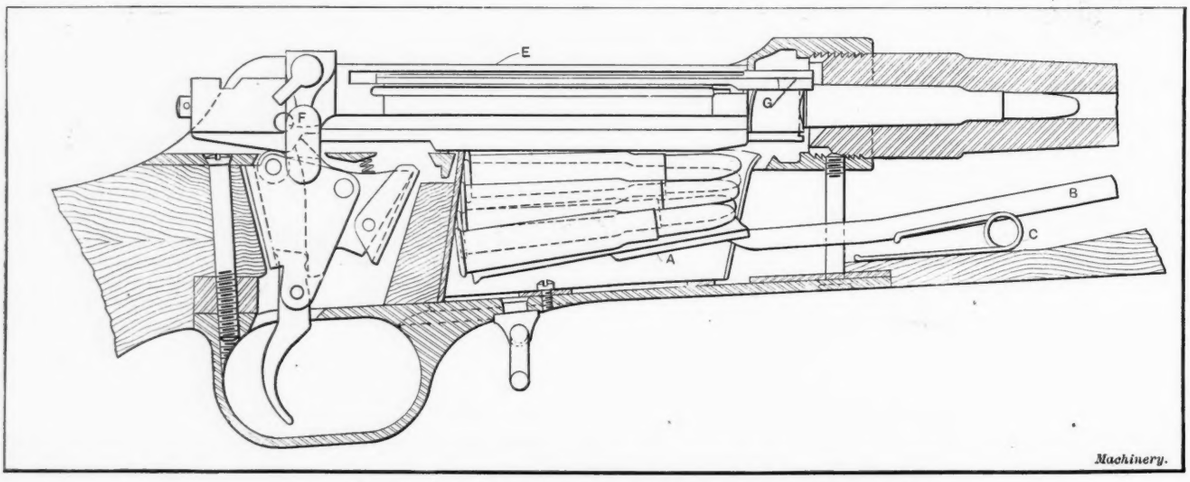


Fig. 4. Sectional View of Ross Rifle showing the Magazine, Bolt and Trigger Action

19. Lifter spring. 20. Lifter screws. 21. Magazine box. 22. Magazine screws. 23. Nuts for band screws. 24. Pawl. 25. Pins and springs for trigger pull. 26. Receiver. 27. Receiver screws. 28. Strap link. 29. Sear. 30. Sight bridge and charger guide. 31. Sight sleeve and base, rear. 32. Sight, rear. 33. Sight base and sleeve, front. 34. Sight hood, front. 35. Sight, front. 36. Spring, main. 37. Stock. 38. Trigger. 39. Trigger guard. 40. Yoke.

In addition to the military rifle, the Ross Rifle Co. also manufactures the various types of rifles shown in Fig. 2. *A* is the 0.280 match rifle equipped with match sights and is

built under N. R. A. regulations for use in match rifle competitions. It has a barrel 30½ inches long and is designed especially for match purposes. The rifle shown at *B* is a 0.280 sporting rifle equipped with the Ross telescope sight. *C* is this rifle equipped with plain sights, and is called the "Ross high-velocity rifle, Scotch deer-stalking pattern"—a rifle designed by Sir Charles Ross especially for deer-stalking purposes. The 0.280 Ross sporting rifle weighs—without telescope sight—seven pounds, three ounces, and has a muzzle velocity of 3100 feet per second, and a muzzle energy of over 3150 foot-pounds. It is not necessary to change the sights for 300 yards, as the trajectory of the bullet is practically flat for this distance.

The rifle shown at *D* is what is called the "Ross straight-pull Model E sporting rifle." This rifle weighs about seven pounds,

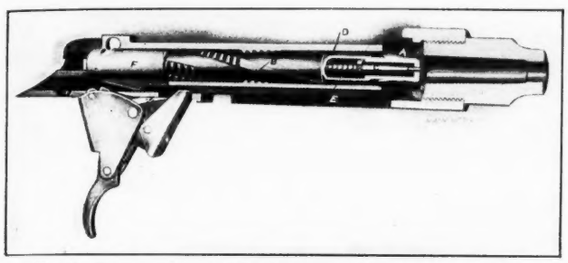


Fig. 5. Sectional View of the Receiver and Bolt Sleeve, with Bolt Seated at Instant of Discharge

two ounces, has a muzzle velocity of 2000 feet per second, and is bored to suit the 0.303 British service ammunition, W. M. C. Winchester, and English-made 0.303 soft-nose for sporting purposes. If so desired, it can be chambered to take 0.35 caliber Winchester cartridges. The rifle shown at *E* is the Ross straight-pull sporting rifle Model R. This rifle is not so expensive as Model E, not being made from select parts. It is chambered for 0.303 British cartridges, and has a muzzle velocity of 2000 feet per second.

To meet the demand for a small caliber target rifle for the militia, the Ross Rifle Co. has designed a 0.22 caliber rifle, as shown at *F*. This rifle embodies the main Ross feature—the straight-pull bolt action—and is of simple design, being composed of few parts. It is a single-shot rifle, the cartridge being inserted through a cut-out at the rear of the chamber on the right-hand side of the barrel. It is chambered to take both 0.22 short and long cartridges. This rifle is given the same care and attention as the regular rifles manufactured by this company. The location of the rear sight is a commendable feature for target practice; it is set on the rear of the straight-pull bolt, as shown in the illustration, thus bringing it close to the eye of the shooter.

Operation of the Ross Rifle

The Ross 0.303 military rifle as well as the 0.303 and 0.280 sporting rifles are equipped with a magazine which holds five cartridges, as shown in Fig. 4. This magazine is of such a width that two cartridges cannot be placed side by side, but overlap one another, as it were, so that they roll freely past each other and are, therefore, easily inserted into the chamber. The cartridges rest on a platform *A* attached to a lifter *B*, the latter being acted upon by a coil spring *C*. When the bolt and bolt sleeve *E* are drawn back by pulling on the handle *F*, the uppermost cartridge rises, and when the bolt is pushed forward it carries the cartridge ahead of it, locating it in the chamber in the barrel.

When the cartridge is forced into the chamber by the bolt, the extractor *G* slips over the head of the shell, a cut being provided in the rear end of the barrel for this purpose; then as the bolt is withdrawn after the cartridge has been discharged, the extractor pulls the empty shell out of the chamber until it comes in contact with an ejector which throws it out of the receiver. As one cartridge is fed into the chamber, the next one comes up flush with the base of the bolt sleeve, being retained in that position by a shoulder on the side of the magazine. So quickly can this bolt action be effected that it is possible to empty the magazine before the first cartridge touches the ground. All the cartridges in the magazine may be discharged without taking the rifle from the shoulder, it only requiring a simple back-and-forth movement of the right hand to eject the empty shell and reload.

A Straight-pull Bolt Action

A peculiar feature of the Ross rifle is its straight-pull bolt action. This rifle differs from others of its class in that it is only necessary to pull the bolt back and forth to open and lock it, extract the cartridge, compress the firing pin, seat another cartridge in the chamber, and then lock the bolt. The construction of the bolt and bolt sleeve are clearly shown in Fig. 5, where the bolt is shown seated at the instant of discharge.

The bolt is locked in its forward position behind two cam-faced projections in the receiver, two cam-faced lugs *A* being provided on the bolt for this purpose. So effective is this method of locking, that the bolt will resist, when locked, a breech pressure of 100,000 pounds. The bolt and bolt sleeve are the most interesting parts of this rifle, and work on the principle of the well-known spiral screw-driver. It is well known that if the pitch of a screw be increased sufficiently, a pressure on the nut in the direction of the axis will cause the screw to rotate, if the nut is prevented from turning. In this case, the bolt sleeve is the nut, which is prevented from rotating by guide slots cut in the sides of the receiver; and the spiral ribs on the bolt, which mesh with spiral grooves in the bolt sleeve, correspond to the screw.

The bolt is provided with two spiral ribs, extending to within 1 inch of the rear face of the lugs, and also two short threaded ribs, ½ inch long at the rear end. The ribs have a pitch of one turn in 6 inches and are 0.200 inch wide. The thread cut in the rear end of these spiral ribs is of the buttress form, ⅛ inch pitch. Four grooves are cut in the bolt sleeve to fit the spiral ribs on the bolt, and the ribs thus formed in the sleeve are threaded to suit the thread on the bolt. During the forward movement of the bolt, the threads are in mesh,

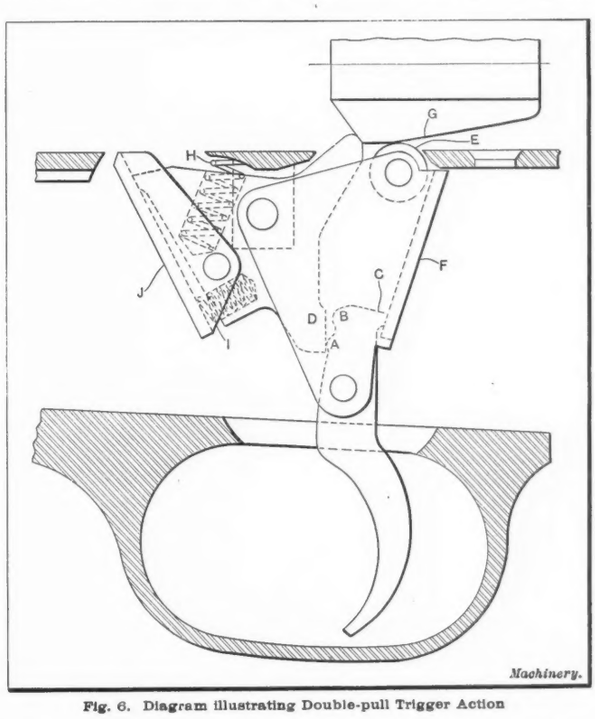


Fig. 6. Diagram illustrating Double-pull Trigger Action

and take all the thrust of forcing the cartridge into the chamber and cocking the action. At the end of the forward movement, when the lugs on the bolt-head strike the barrel, an ingenious arrangement of camming surfaces throws the threads out of mesh, bringing into play the spiral ribs, which revolve the bolt lugs into the locked position behind the cam-faced projections in the receiver. These operations are reversed on the backward stroke.

As shown in Fig. 5, the firing pin *C* passes centrally through the bolt *D* and is surrounded by a coil spring *E*, to the compression of which it owes its propulsive force. This firing pin is controlled by a cocking piece *F*, which is held to it by

a cone-shaped pin fitting in a groove cut in the firing pin, the cocking piece, in turn, being controlled by the sear *D* (see Fig. 6). When the trigger is pulled, the sear operates and thereby releases the cocking piece, with the result that the firing pin strikes the primer in the cartridge. These parts are so related to one another that the cartridge cannot be discharged without first seating and locking the bolt-head behind the locking projections in the receiver. If the bolt should not be pushed entirely home and the trigger should be pulled, either the cartridge would not explode or the bolt would seat and lock before the explosion could occur, thus eliminating any disastrous result and making the bolt absolutely safe and reliable.

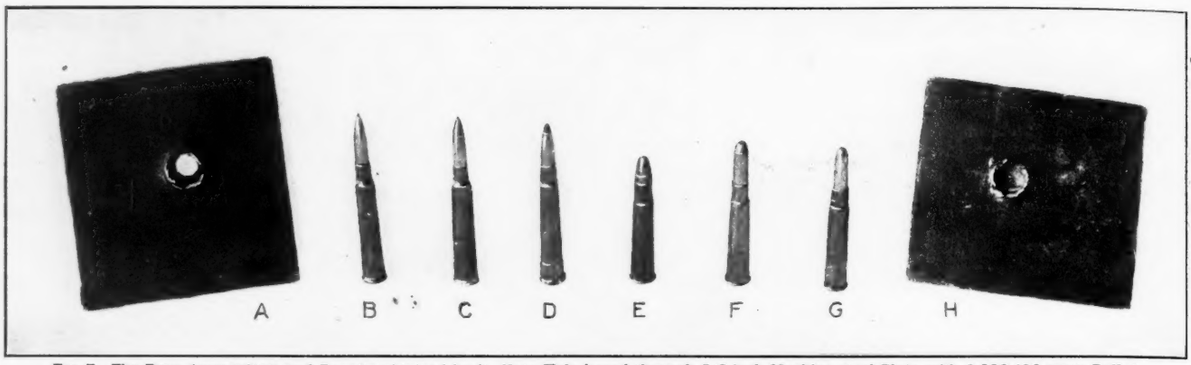


Fig. 7. The Ross Ammunition and Results obtained by it—Note Hole bored through 5/8-inch Machine-steel Plate with 0.280 180-grain Bullet

Double-pull Trigger Action

The military and sporting rifles now being manufactured by the Ross Rifle Co. are equipped with what is called a "double-pull trigger action." This consists mainly of a trigger, pawl, and sear, as shown in Fig. 6. The upper end of the trigger is provided with two rounded projections *A* and *B*, and a projecting lug *C*, the latter bearing against the bracket *F*, and assisting in cocking. The first part of the pull on the trigger brings the projections *B* in contact with the lower nose of the sear *D* and at the same time brings the roller *E*, held in frame *F*, in contact with the cocking piece *G;* this action also depresses the spring *H*. On a further pull of the trigger of 5½ pounds—on the military rifle—the sear is released from the cocking piece, and the spring in the bolt, against the tension of which the sear operates, draws in the cocking piece, this, in turn, carrying the firing pin that discharges the cartridge.

The spring *I* keeps the pawl *J* in contact with the forward nose of the sear, the pawl acting as a resistance member during the cocking operation.

In rifles equipped with the ordinary trigger action, the sportsman is not sure at just what point the firing pin will be released and, therefore, is not always prepared when the cartridge is discharged. With this double-pull trigger action, he knows exactly when the cocking piece will be released and is aware of the exact moment when the cartridge will be discharged. The resistance is always the same for the first part of the pull, so that one can tell when the fingers are cold and stiff just how much pressure is being applied and at what point the cocking piece will be released.

A Study in Speeds

The velocity of the 0.280 Ross sporting rifle is so remarkable that it may be interesting here to make a few comparisons. The muzzle velocity, or to be more correct, the initial velocity, at 90 feet from the muzzle, is 3100 feet per second, or about 35 miles per minute, developing a muzzle energy of over 3150 foot-pounds. The great linear velocity of this missile does not impress us so much as its rotative speed, because we have nothing with which to compare it. While traveling at this rapid rate of 35 miles per minute in a linear direction, the bullet also rotates on its axis at the rate of 257,736 revolutions per minute, the rifling in the barrel having a twist which gives one turn in 8.66 inches. The rotative speed is found by the following formula:

$$R = \frac{V \times 12 \times 60}{P}$$

in which

R = the rotative speed, or R. P. M.;
V = the muzzle velocity;
P = the pitch or twist of the rifling in the barrel.

The peripheral speed of this small missile would be:

$$\frac{0.280 \times 3.1416 \times 257{,}736}{12} = 18{,}893 \text{ feet per minute.}$$

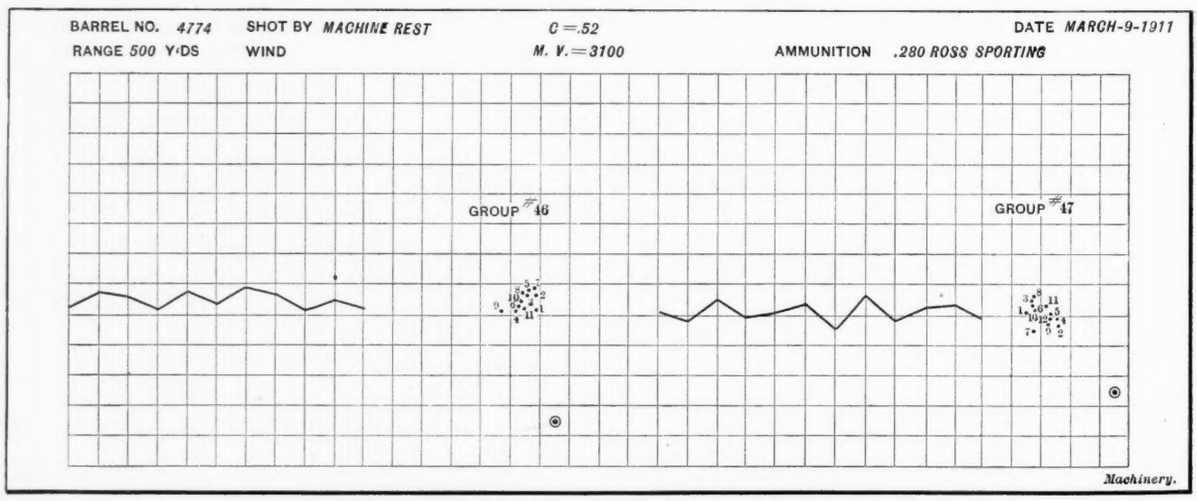


Fig. 8. Interesting Target Groups made by 0.280 Ross Sporting Rifle at 500 Yards

This enormous rotative speed, 257,736 R. P. M., is more than eight and one-half times greater than the highest speed known at the present time, this being the speed of the rotor of a small De Laval turbine, which makes 30,000 R. P. M. When we consider the difficulty of making a rotor which will revolve at a speed of 30,000 R. P. M., we have an idea of some of the perplexing problems confronting the ballistic expert. Rotating the bullet at such an enormous speed, according to the Ross Rifle Co., does not have a deteriorating effect

on the barrel, as it is claimed that the 0.280 barrel will last three times as long as the 0.303 barrel, under ordinary conditions.

Some Remarkable Results Attained with the Ross Rifle

After reading the foregoing description, the reader may be sufficiently interested to take note of some of the remarkable results attained with the 0.303 service and the 0.280 sporting rifles manufactured by the Ross Rifle Co. In the rifle competitions which took place at Bisley, England, in the present year, Private Clifford, of Canada, with the regular 0.303 Ross military rifle, won both the King's and Prince of Wales' trophies. This feat had never before been accomplished by any one man,—a most remarkable result. The Canadian team won the McKinnon cup and tied the English team for first place in the competition for the Kolapore cup. When we consider that all of the British Colonies were represented at this competition, the importance of winning such trophies seems the more remarkable. The 0.280 Ross rifle and ammunition also came in for a fair share of the "spoils", winning six matches, in which the ranges varied from 900 to 1100 yards, and tying for first place in two of the competitions.

The remarkable penetrating power of the 0.280 Ross rifle as compared with the ordinary 0.303 service rifle is clearly illustrated in Fig. 7. At *A* and *H* are shown two ⅝-inch machine-steel blocks. The block shown at *A* has a hole "drilled" clear through it; this was accomplished by the 0.280 Ross cartridge with the nickel jacket bullet shown at *B*. The plate shown at *H* was also placed at the same distance—100 feet—and the service cartridge shown at *G* was used in the ordinary Mark II** rifle. This bullet, which is also nickel-jacketed, made a depression only 3/16 inch deep, which is a fair comparison of the remarkable penetrating power of the 0.280 rifle and ammunition. The nickel-jacketed 180-grain bullet, fired from the 0.280 rifle, will penetrate eighty pine boards, ⅞ inch thick, placed at a distance of fifteen feet from the muzzle. Since the energy required to penetrate the fleshy part of a man's body is equal to that required to penetrate a one-inch pine board, this bullet, theoretically speaking, will mow down seventy men placed in a line at a distance of fifteen feet from the muzzle.

The cartridges shown at *C* and *D* are other types of ammunition used in the 0.280 Ross sporting rifle, the one shown at *D* being the regular copper tube bullet used especially for hunting purposes. The cartridges shown at *E*, *F* and *G* are representative of the ammunition used in the 0.303 service rifle.

Not only has the 0.280 Ross rifle extraordinary penetrating power, but it also shoots accurately, so much so that it carries off all the trophies; that is, of course, in the hands of experienced riflemen, and under ordinary conditions. Fig. 8 shows two representative groups made with a 0.280 Ross at 500 yards, the rifle being held in a machine rest when the two groups, numbers 46 and 47, were made. The target represented in the illustration is plotted off in six-inch squares, so that out of the eleven shots fired, not one of them was outside of an eight-inch circle. The zigzag lines to the right and left show the plotting of the various shots in the groups. When we consider that the regulation size of the bull's eye at 500 yards is 12 inches, the marvelous accuracy of this rifle will be fully realized.

* * *

The Bureau of Statistics, Department of Commerce and Labor, has undertaken to publish monthly the sailing dates of all vessels leaving the various ports of the United States to various ports in all countries of the world. A sailing list of this kind will undoubtedly prove useful to many exporting manufacturers and can be had upon application to the Bureau. It will be published each month in ample time to enable merchandise or passengers from interior parts to reach the seaboard in time for sailing dates.

* * *

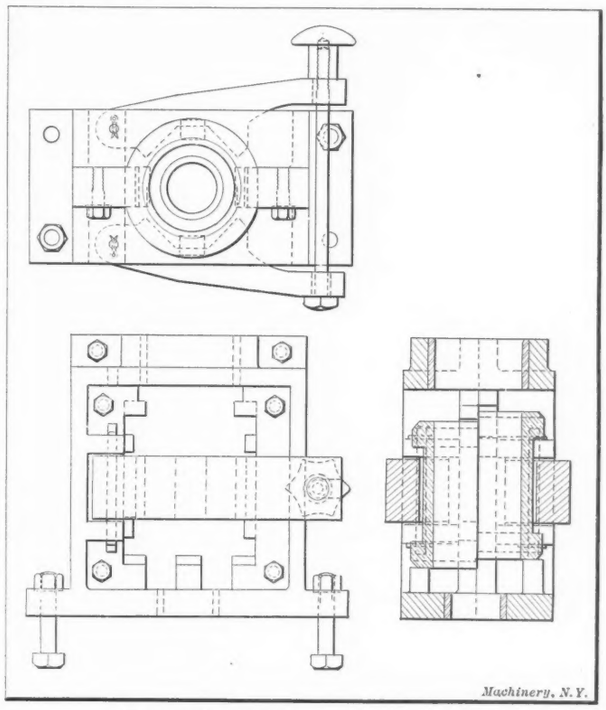
The consumption of aluminum throughout the world is increasing very rapidly according to a recent statement in the *Daily Consular and Trade Reports*. A German source is quoted as stating that in 1909 the amount consumed exceeded 34,000 tons—a marked increase over previous years.

JIG FOR BORING BRASSES

The accompanying illustration shows a jig used for boring brasses for lathe headstocks. This jig is in use in the shops of the Walcott & Wood Machine Co., Jackson, Mich. By its use, it is possible to obtain accurately bored brasses at a cost of only one-tenth of that at which they could be produced by previously used methods. Until the jig method referred to was adopted, the brasses were bored in the lathe; now they are bored by the use of an end mill in a drill press.

The first operation on the brasses is to plane the faces of the half circular parts; then they are rough-turned on the outside. After these operations are completed, the brasses are ready to be put into the jig shown in the illustration, for boring in the drill press. An end mill is first used for the roughing cut, after which the holes are finished by a reamer. The brasses are then put on a mandrel and the outside is finish turned. Finally they are finish reamed in place in the headstock.

The most interesting feature of the method is the construction of the jig used. This is made in two completely separate halves, which are screwed together. Locating points



Jig used for Boring Brasses in the Drill Press

for the brasses are planed so that the brasses rest with their planed faces against the lugs in the jig at the exact center line of the device, as shown in the sectional view. The two halves of the brasses are offset as indicated in order to permit each half to get a bearing in the jig. In this way it is possible to bore all the brasses exactly alike and they do not have to be made in pairs, as before; any one half will properly fit any other half. The most valuable feature in addition to interchangeability is, of course, the rapidity with which the work can be performed in the drill press as compared with boring in the lathe.

* * *

Steel castings containing vanadium should never be used without annealing. In the unannealed state they are more brittle than plain carbon-steel castings. In annealing vanadium steel castings, it should be observed that a somewhat higher temperature is required than is used when annealing ordinary steel castings. A temperature of at least 1500 degrees F. is necessary, and it is preferable that a temperature of 1560 degrees F. be used. Rolling mill pinions made from vanadium steel castings have proved to have from two to three times the life of carbon-steel pinions and from one and a half to two and a half times the life of nickel-steel pinions.

SOLDERS, THEIR CHARACTERISTICS AND USES*

Solder, used for joining metallic surfaces or edges, is almost always composed of an alloy of two or more metals. The solder used must have a lower melting-point than the metals to be joined by it, but the fusing-point of the solder should approach as nearly as possible to that of the metals to be joined so that a more tenacious junction is effected. There is a great variety of solders, bearing the following names: hard, soft, brass, silver, gold, copper, tin, plumbers' and many others—the name designates in most cases their use. There are, however, broadly speaking, only two types of solder, that is, hard and soft. The former fuses at a red heat, while the latter melts at a comparatively low temperature.

Soft Solders

Soft solders consist chiefly of lead and tin although other metals are occasionally added to lower the melting-point. The fusibility of lead-tin alloys increases with the percentage of tin up to a certain point, but when the tin exceeds 67 per cent, the melting-point rises gradually to the melting-point of the tin. Soft solders are termed common, medium and fine according to the tin content, those containing the most lead being the cheapest and having the highest melting-points.

Fine or best solder is largely used for soldering Britannia metal, brass and tin-plate articles. The soft solder called "common" is used by plumbers for ordinary work, this solder containing two parts of lead to one part of tin. Fine solder is also used for soldering cast iron, steel, copper and many alloys. For iron and steel, rosin or sal ammoniac is used as a flux, but for copper and its alloys, chloride of zinc is usually employed. Solder composed of two parts of lead and one part tin is termed in England "plumbers'" sealed solder and is stamped by an officer of the "Plumbers' Company."

The best solders are made from pure lead and pure tin, but the use of scrap metal is very largely employed, and this is likely to contain impurities, such as antimony. Antimony improves the appearance of solder, and thus deceives the buyer, who is chiefly guided by the brightness of the surface. Antimony also renders the solder less fluid when melted and tends to prevent perfect adhesion of the surfaces. Moreover, the solder has a greater tendency to corrode, so that antimony can be called an objectionable impurity. Zinc, when present even in small quantities, has an injurious effect on soft solder, causing the solder to flow sluggishly. Aluminum acts in a similar way. Phosphorus when added in small amounts renders soft solder very "lively", that is, the solder has a tendency to form into small globules and run freely over the surface on which it is being applied. Too much phosphorus is injurious, and if it is added to thin the solder it should be in the form of phosphor-tin. One or two ounces of five per cent phosphor-tin to one hundred pounds of solder is generally sufficient.

In melting solder scrap, oxides are formed, and some of these are likely to become entangled in the molten metal, causing it to become thick. To obviate this, vigorous stirring with a stick is necessary in order to bring the dross to the surface. The tendency of lead-tin alloys to thicken depends upon the length of exposure to the atmosphere and the area exposed, more dross naturally forming on a large area than on a smaller one. For this reason, it is preferable when melting lead to use a deep narrow vessel.

Thick metal may be purified by reducing the oxide by means of charcoal, care being taken to prevent the metal from getting too hot, as the rapidity of oxidation increases with the temperature. Stirring the metal with a stick serves the same purpose; of course, the wood must be pushed to the bottom. Some use raw bone instead of wood, but the odor given off is objectionable. When dross in large quantities is to be treated, a reverberatory furnace is the most economical, but small quantities should be treated in a crucible furnace. The advantage of the reverberatory furnace is that the surface of the metal is not exposed to the air and therefore not oxidized. The melting-point of lead is 618.8 degrees F. An addition of tin lowers the melting-point. The melting-point of tin is 446 degrees F. An addition of lead to tin also lowers its melting-point. There is, however, a limiting point beyond which the temperature can not be lowered by either the addition of tin or lead.

The melting-point of lead-tin alloys, and the hardness test as obtained by the Brinell method, is as follows:

Percentages of		Melting Point	Hardness Test
Tin	Lead	(Degrees F.)	(Brinell Method)
0	100	618.8	3.9
10	90	577.4	10.1
20	80	532.4	12.16
30	70	491.0	14.5
40	60	446.0	15.8
50	50	401.0	15.0
60	40	368.6	14.6
66	34	356.0	16.7
70	30	365.0	15.8
80	20	388.4	15.2
90	10	419.0	13.3
100	0	466.0	4.1

These results show that the hardest alloy is one that contains 66 per cent of tin, and 34 per cent lead, which is practically the eutectic alloy and therefore the one having the lowest melting-point of all the alloys. The results also show that tin is slightly harder than lead.

Soldering and Brazing

As two pieces to be soldered must be thoroughly alloyed with the material used as a solder, the temperature must be raised and maintained at such a point that inter-penetration can take place completely. For this reason it is necessary that the piece joined be perfectly clean, and means must be provided to prevent oxidation during soldering, oxides tending to prevent interfusion. This is accomplished by using a coating of some substance that melts at the fusing temperature of the solder, and thus excludes the air. The coating should have a solvent action on the oxide, thus keeping the metal clean and enabling the metal and solder to unite thoroughly. The fluxes generally used are rosin, sal ammoniac, zinc, chloride and borax. The flux is added first and the solder melted by means of a flame or soldering iron, the latter first being smoothed with a file and then properly tinned; otherwise no satisfactory soldering can be done. In all cases where zinc chloride is used as a flux the article should be cleaned after soldering to prevent subsequent corrosion of the metal.

A new soldering substance called "tinol," which has many advantages over the ordinary metal, especially for joining parts with a jet flame, can now be obtained. This solder differs materially from the solder hitherto produced being in the form of a paste, which contains both solder and a flux for dissolving the oxides. The solder is composed of tin and lead in suitable proportions. Six different alloys are made up in this form, ranging from twenty parts tin and eighty parts lead to pure tin. Another alloy is made of tin, lead and cadmium having a melting-point of 248 degrees F, which is especially useful for instrument work, as it can be applied without affecting the temper or color of steel springs.

Hard Soldering

Hard soldering or brazing is used for joining such metals as copper, silver and gold, and alloys such as brass, German silver, gun metal, etc., which require a strong joint and a solder approaching somewhat near in color to that of the metal to be joined. For hard soldering a red-heat is necessary, and borax is required as a flux to protect the metal from oxidation, and to dissolve the oxides formed. Heating for brazing cannot be accomplished with a soldering iron, but must be effected by a blowpipe.

Fusible Alloys

This is the name given to a series of alloys which can be melted at comparatively low melting temperatures, consisting of lead and tin to which bismuth, cadmium or mercury is added. Tin and bismuth both possess low melting-points and readily compound in all proportions when fused together. A small proportion of bismuth added to tin increases the hard-

* Abstracted from the Birmingham *Engineering and Mining Journal.*

ness, and imparts greater luster and fusibility. The presence of bismuth in tin greatly increases the tendency to oxidation. An alloy of twenty parts tin to one part bismuth is but slightly ductile. Alloys composed of tin, bismuth and lead are valuable for making fusible solders, such as are used for safety pumps. The most fusible alloy of tin, bismuth and lead consists of equal parts of lead and tin and twice the quantity of bismuth. This composition melts below 212 degrees F. The addition of cadmium lowers the melting-point of many alloys, some of which are fusible in boiling water. The melting-points of these fusible alloys are as follows:

Percentages of				Melting Point
Cadmium	Tin	Lead	Bismuth	(Degrees F.)
17.30	18.24	32.00	32.45	155.1
13.60	19.00	33.40	34.00	153.5
14.30	19.00	31.10	33.60	150.0
4.00	—	44.00	52.00	190.4
9.00	—	57.7	33.30	203.0

Brass Solders

Brass solders are composed of copper-zinc alloys, and are employed for joining brass parts and other copper alloys by fusion. The melting-point of copper-zinc alloys depends upon the percentage of zinc, and as the proportion of zinc increases the melting-point is lowered. The fusing-point of solders should be as close as possible to that of the article to be soldered, as a more tenacious joint is thereby secured. An easily fusible solder may be made from two parts of zinc to one part of copper, but the joint will be weaker than when a solder more difficult to fuse is employed. A readily fusible solder may be made with 44 per cent copper, 50 per cent zinc, 4 per cent tin and 2 per cent lead. Alloys containing much lead, however, should be avoided, since lead does not transfuse with brass and thus decreases the strength of the joint. A hard solder for the richer alloys of copper and zinc may be produced from 53 parts copper and 47 parts zinc. Brass solder is sometimes used for soldering copper and iron articles, and these metals have a much higher melting-point than brass, thus allowing the use of a richer copper alloy. In these cases tin is often added as one of the ingredients, but it should be sparingly used as it increases the brittleness of the solder. The addition of tin to brass lightens the color, giving it a gray tint. The melting-points of copper-zinc alloys in different proportions are as follows:

Percentages of		Melting Point
Copper	Zinc	(Degrees F.)
100	0	1980
96	4	1967
86	14	1890
80	20	1846
76	24	1796
72	28	1756
71	29	1746
66.4	33.6	1684
63	37	1666
60	40	1634
50	50	1616
48	52	1598
41	59	1544
35	65	1501
33	67	1477
29	71	1467
24	76	1364
20	80	1301

In making brazing solders it is important that the constituting metals should be commercially pure, as impurities interfere with the color, malleability and strength. These solders are only used in the crushed or granulated form, and are made by pouring the alloy into an iron mold and compounding it while in the highly heated state. Some manufacturers pour the molten metal into cold water, dropping it from a certain height, the metal in its descent passing through a wet broom or similar contrivance, thus dividing it into fragments. The granulated metal is afterwards put through sieves of different meshes, to bring together grains of uniform size. A fine and useful solder is obtained by arranging a horizontal pipe at some distance above the surface of a tank of water, and connecting this horizontal pipe with a water reservoir by means of which a jet of water is thrown horizontally over the lower vessel containing water. On this jet of water the molten metal is poured thus dividing it into grains of different sizes, the variation in size depending on the force or pressure of the water. A variety of different brazing solders which are widely used, with their characteristics, are as follows:

Percentages of				Character-	
Copper	Zinc	Tin	Lead	istics	Color
58	42	—	—	very strong	reddish yellow
53	47	—	—	strong	reddish yellow
48	52	—	—	medium	reddish yellow
54.5	43.5	1.5	0.5	medium	reddish yellow
34	66	—	—	easily fusible	white
44	50	4	2	easily fusible	gray
57	28	15	4	white solder	white

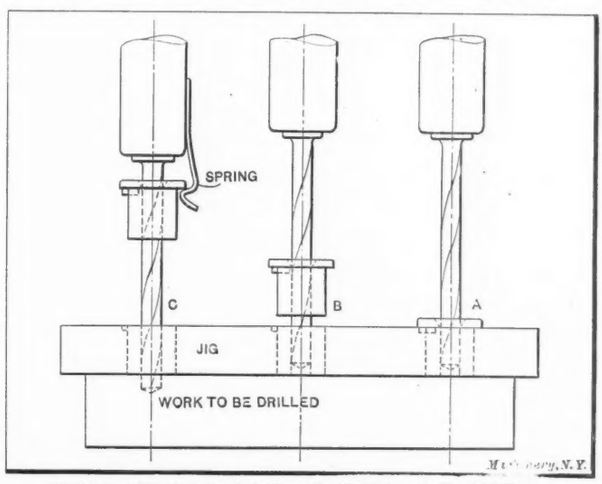
German Silver Solders

Solders for German silver are generally made of the same materials as those which compose the alloy to be soldered, but in such proportions that the melting point is lowered. In some cases silver solder is used for uniting German silver articles, and German silver solder is also used for soldering articles of iron and steel on account of its high melting-point and tenacity. German silver solder is known under different names, as argentan, arguzoid, etc. It is rendered moderately fusible by an addition of zinc to the copper and nickel. The ease with which it can be pulverized depends on the proportion of zinc. If the solder is too brittle it indicates too much zinc, which defect can be remedied by adding the requisite copper and nickel. For soldering alloys composed of from 16 to 22 per cent nickel, the following proportions may be used as a solder: Copper 47 per cent, nickel 11 per cent, and zinc 42 per cent; from experiments which have been conducted by the author, it has been found that 50 per cent of nickel may be used, but beyond that proportion the solder becomes very porous.

* * *

ALIGNING THE SPINDLES OF A MULTIPLE-SPINDLE DRILL PRESS

In a circular issued by the Baush Machine Tool Co., Springfield, Mass., is shown the method illustrated in the accompanying engraving for aligning the spindles of a multiple-spindle drill press with the bushings in the jig. Those familiar with this work know that when aligning the spindle, if the drill is small, it is difficult to see whether the drill deflects when entering the bushing or not, owing to the fact that the drill is pointed and the top of the bushing is bell-mouthed. This



Method of Aligning the Spindles of a Multiple-spindle Drill Press.

trouble can be overcome by using a removable bushing, and sliding it up on the drill as shown at *B*. Then when the spindle is brought down, as the bushing and the jig both have sharp corners, it can easily be seen whether the bushing is in line or not. The bushing is prevented from rotating in the jig, as shown at *A*, by a small key-pin fitting in a corresponding slot in the jig.

When deep holes are to be drilled, an auxiliary spring catch, shown at *C*, can be used to advantage. After the drill has started properly into the work, the bushing is removed from the jig and held by the spring. This allows the chips to escape, and also reduces the wear on the bushing.

MAKING MILLING MACHINE SPINDLES

By JOHN GOETZ*

On a high-grade milling machine, one of the parts which requires very careful attention in machining is the work-spindle. If care is not exercised in the machining and grinding operations, so that the spindle when finished will run perfectly true, poor work will be accomplished by the machine. The Kempsmith Mfg. Co., Milwaukee, Wis., employs some novel and interesting methods in the manufacture of the work-spindles for its milling machines, a description of which is given in the following article. The accompanying illustration Fig. 1 shows a work-spindle for a No. 3 Kempsmith plain and universal milling machine. This spindle is made from a drop-forging of special steel. It is received in the machining department in the condition shown at *A*, Fig. 2, a completed spindle being shown at *B* with the gear assembled on it.

The forgings for the spindles are carried from the stock-room to the lathe department on the special trucks shown in Fig. 3. The spindles, however, shown on the trucks have been machined and are ready for grinding. A tag is attached to one of the spindles on the truck, and a blueprint accompanies the lot on which the finished sizes are given, as shown in Fig. 1.

The Machining Operations

On the blueprint which accompanies the spindle forgings are given the machining operations in their correct order. They are as follows:

1. Measure, mark and cut off to length;
2. Straighten and center;
3. Rough turn nose of spindle to the following dimensions 3⅛, 4¾ and 3.740 inches, respectively, and face (see Fig. 1);
4. Rough turn on lathe with multiple-tool turning attachment;
5. Bore ⅞-inch hole through spindle;
6. Rough bore and ream tapered hole in nose of spindle;

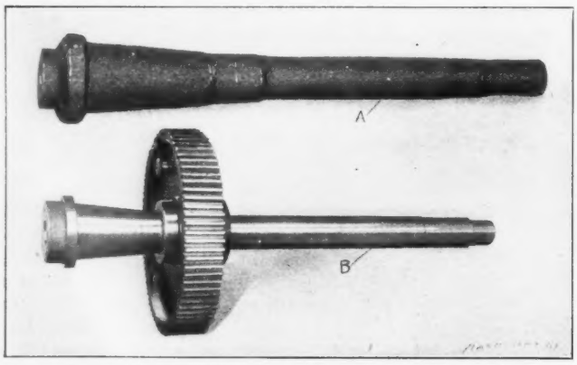


Fig. 2. The Work-spindle in the Rough and Finished Conditions

7. Finish bore tapered hole in engine lathe (for grinding), put in recess *A*, and face nose *N*; (see Fig. 1).
8. Broach tang slots in milling machine;
9. Finish turn nose end to 3 inches diameter;
10. Finish turn in lathe with multiple-tool turning attachment;
11. Bore and tap rear end of spindle;
12. Mill keyways *E* and *F* (see Fig. 1);
13. Mill all threads and put on nose guard, or knurled nut;
14. Grind external diameter;
15. Grind internal tapered hole.

Roughing-down a Milling Machine Work-spindle

After the forging has been straightened and centered, it is put into the lathe for which we have made a multiple-tool

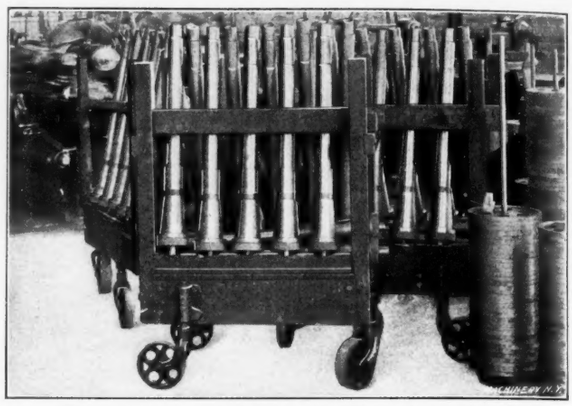


Fig. 3. Trucks used in Carrying the Work-spindles to the Various Departments

turning attachment, shown in Fig. 4. Here it is roughed down by four turning tools *A*, *B*, *C* and *D*, respectively. Turning tool *D* is held in a "floating" holder that is actuated by a cam *E*, this cam giving the correct movement to the holder, so that the part *F* of the spindle is turned tapered. The other tools *A*, *B* and *C* turn down the straight

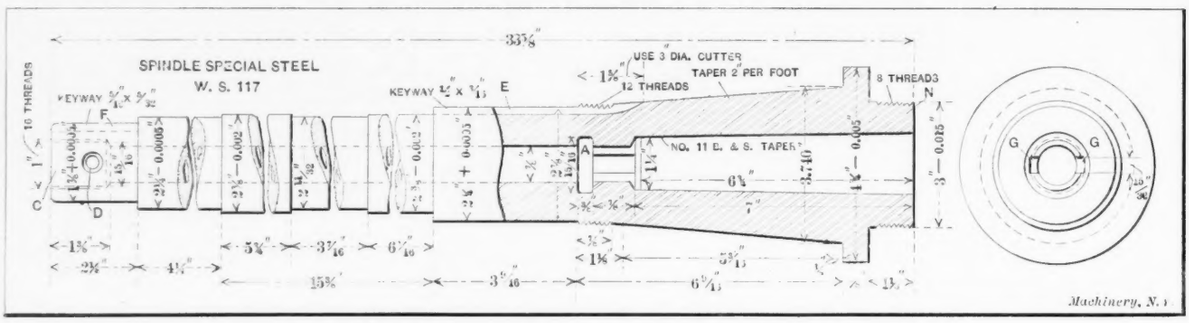


Fig. 1. Work-spindle for a No. 3 Kempsmith Plain and Universal Milling Machine

portions of the spindle, as shown in the illustration. This turning attachment may be removed by unscrewing the two nuts at the rear, when it can be lifted off the carriage. Lubricant is supplied to the turning tools by means of flexible steel tubes *G* which are connected to a general distributing tank. This means of lubricating has been adopted entirely throughout the Kempsmith shops, and has been found to be more satisfactory than individual pumps located at the machines. A general view of the lathe and the rough turning operation are shown in Fig. 5. Here the pipe *I* is shown, which supplies lubricant to the tubes *G*. The lubricant is drained away from the bed of the machine by a pipe *J*, which conducts it to a distant tank below the floor, equipped with a rotary pump for supplying the system with lubricant.

Now that the spindles have been rough turned, they are taken to a boring machine (in the trucks shown in Fig. 3), where the ⅞-inch hole is bored with a special oil-tube twist drill. The next operation is to rough bore and ream the tapered hole, which is performed in a lathe especially made for this purpose. After rough boring and reaming the tapered hole, it is finish bored, so that it is in a suitable condition for truing up the spindle for grinding. The recess *A*, Fig. 1, is also machined at the same setting, and the nose end *N* of the spindle is faced.

Broaching the Tang Slots

The spindle is now in condition for broaching the tang slots *G* used in driving the work-arbor. This is accomplished in a universal milling machine as shown in Fig. 6. The

* Address: Superintendent Kempsmith Mfg. Co., Milwaukee, Wis.

broaching-tool holder is held in the Kempsmith regular slotting attachment, and works in a sleeve *A*, which is fitted into the tapered hole of the spindle. This sleeve *A* has a keyway cut in it to prevent the broaching-tool holder *B* from turning

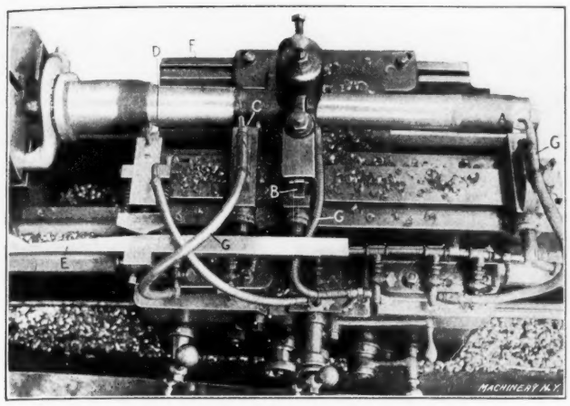


Fig. 4. Roughing-down the Work-spindle

while in operation. The broaching cutter *D* is adjusted by a collar *C*, which draws a wedge under it, and in this way raises the broaching tool to the proper height for each cut.

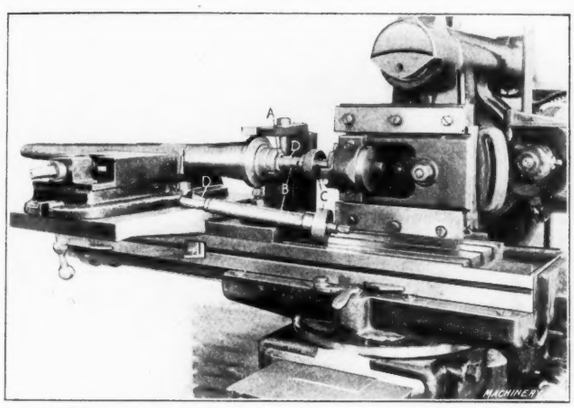


Fig. 6. Broaching the Tang Slots in a Milling Machine

The recess *A* in the spindle, Fig. 1, provides a clearance at the end of the cut, and allows the chips to drop away from the tool. The broaching-tool holder and adjusting collar are

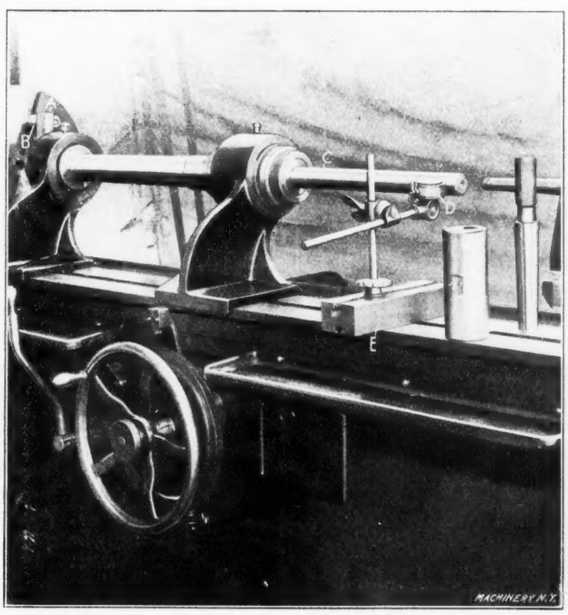


Fig. 8. Testing the Truth of the Tapered Hole by a Dial Test Indicator

shown disconnected from the machine, lying on the table in Fig. 6. As is shown in Fig. 1, two slots *G* are broached in the spindle, and the sleeve *A*, Fig. 6, is also provided with two keyways (spaced 180 degrees apart), the broaching-tool holder being revolved for the second slot. After broaching, the center plug is inserted in the spindle, and is not removed

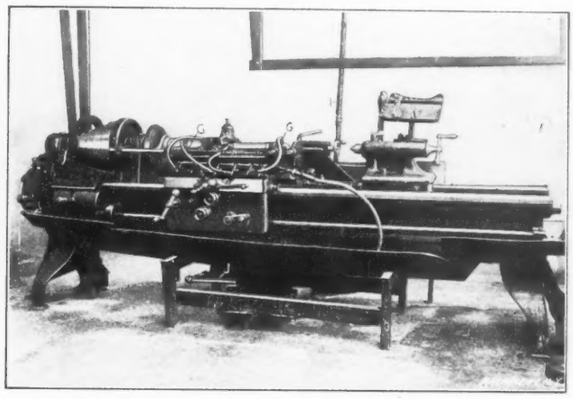


Fig. 5. General View of the Lathe in Fig. 4, showing Lubricating Tubes

until the spindle is ready for the internal grinding operation —No. 15.

With the center plug inserted in the nose end of the spin-

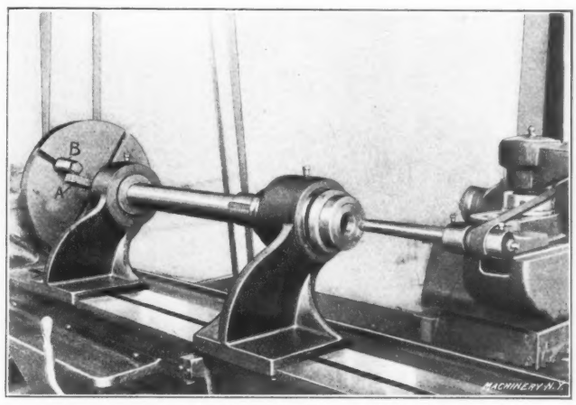


Fig. 7. Method of Holding Work-spindle while Grinding Hole

dle, the nose is now turned to the required diameter—3 inches—and the outside diameter finish-turned in a lathe similar to that shown in Fig. 5. The hole *C* in the rear end of the

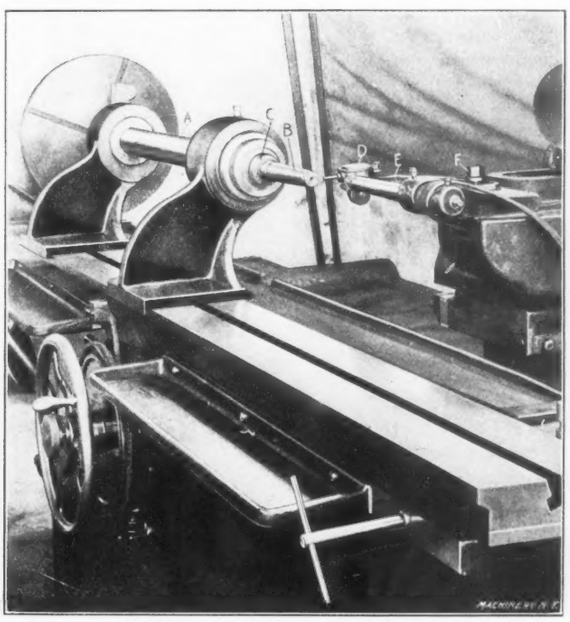


Fig. 9. Improved Method of Setting the Table to the Required Angle by a Dial Test Indicator

spindle (see Fig. 1) is then drilled and tapped in the lathe, and the set-screw hole *D* drilled and tapped in the drill press.

After this, the keyways *E* and *F* are milled in the milling machine, this operation being too simple to need description.

The work-spindles are now taken to a Pratt & Whitney thread miller, where the threads are cut on the nose and shank of the spindle. These threads are perfectly formed, as they are milled by cutters which are ground to the correct shape. After milling the threads, the spindle is placed in a universal grinder, where the external diameter is ground to the required size.

Setting the Spindle for Grinding the Tapered Hole

The most important operation in connection with the manufacture of a milling machine spindle, and the one which requires the most careful attention, is the grinding of the tapered hole. If this is not done correctly, and is not made to run true with the outside of the spindle, trouble will result. When grinding, the spindle is held in brackets, as shown in Fig. 7, and is driven by a dog *A*, clamped to the rear end of the spindle and which, in turn, is driven by a bolt *B* fastened to the faceplate of the grinder.

The spindles are tested before being removed from this machine, as shown in Fig. 8. A test-arbor *C*, which is ground perfectly true, is placed in the tapered hole, while a dial test indicator *D*, fastened to the block *E* as shown, is held against the revolving arbor. If it is found that the arbor does not run "dead" true, the internal grinding attachment is brought into operation, and light cuts are taken, until by a final inspection it is found that the arbor runs absolutely true. This inspection, however, is not the last one made to determine whether the spindle is ground perfectly true or not, as it is again finally inspected in the inspection department, but as this grinding operation is very carefully conducted, the spindles seldom come back for correction.

It is the usual custom for grinder hands, when doing taper work, to set the grinder table as near to the graduation mark as possible; then by the "cut-and-try" method they endeavor to obtain the desired result. The writer has known of some who never could get the taper just exactly right, and to overcome this difficulty the following method has been adopted. An arbor which has been ground perfectly true, and tapered on both ends, one end fitting the tapered hole in the spindle and the other ground to the taper that it is required to reproduce in the hole in the spindle, is placed in the tapered hole in the spindle as shown in Fig. 9. After the work-spindle *A* is set up in the jig as shown, the tapered arbor *B* is inserted. A dial test indicator *D* is then fastened to a bracket *E* which, in turn, is held to the internal grinding head by a collar screw *F*. The pointer of the indicator is set directly on the center of the arbor *B*, and the table traversed back and forth, until no movement is transmitted to the indicator needle, thus showing that the grinder table is set to the desired angle. When the table has been set correctly, the nut *C* is turned to withdraw the arbor *B*. It is then an easy matter to grind the hole in the spindle to the correct taper. It is absolutely necessary that the wheel center be at exactly the same height as the spindle center.

* * *

According to *Industritidningen Norden*, the General Swedish Electric Co., of Västeras, Sweden, is at the present time engaged in the building of five generators for a Norwegian electro-chemical industrial concern, each of which is of 17,000 kilowatts capacity. These generators are presumably the largest ever built. The weight of each machine is somewhat over 275 tons, the roter alone weighing 102 tons. The finished shaft of the rotor weighs nearly 18 tons.

* * *

After the depression in the ship-building trade which has made itself felt for some time, the British ship-yards are apparently again experiencing a boom. The tonnage now under construction in the ship-yards in the United Kingdom represents the highest record in the annals of British ship-building, there being at the present time 496 vessels with a gross tonnage of 1,476,400 tons under construction. Out of this total 415,000 tons represent war-ships under construction.

THE BRAZING OF METALS

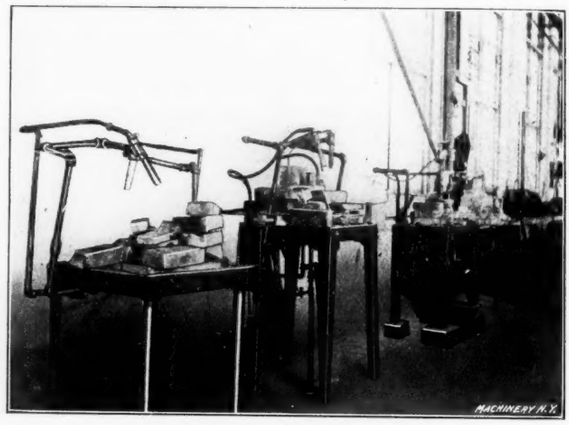
By J. L. LUCAS*

Although brazing, or the process of uniting two pieces of metal by means of a third metal which will melt at a lower temperature, is one of the oldest of the mechanical arts, at the same time it is one of the least understood. Ask a good brazer what makes the metals unite, or what test a good brazed joint will stand, and he is not able to tell you; he can do the "trick" all right, do it well and know when it is a good job, but that is all. The process of brazing was well known to the ancient Egyptians and was also used by the old German "monks" as many relics of their work indicate.

Cleaning

The secret of successful brazing is the thorough cleaning of the joint that is to be brazed. "Well cleaned is half brazed" is a true and well-known saying. While you can boil and burn out the dirt in a joint in the process of brazing, it is a poor way to do it, and the result will be anything but a good job.

The cleaning process should not be a wash or a dip, but a mechanical operation, that is, filing or grinding, or better



A Gas Furnace Brazing Equipment

still—the sand blast. A sand blast not only takes off the rust and dirt, but it leaves the sanded surface of the metal full of minute holes, which makes the best kind of a surface to receive and hold the spelter. It is also an ideal method for cleaning the work after brazing, as it can be done cheaper and better than in any other way.

Brazing a Plain Joint

In brazing a plain joint, first clean the joint well, as previously stated. If brass parts are to be brazed they can be cleaned by "dipping," when they will take the spelter without any trouble, but a steel-to-steel or iron-to-iron joint should be mechanically cleaned. After this is done, the joint should be painted with a solution of calcined borax (burnt borax) or any of the brazing compounds in use. The pieces are then lightly driven together, or if the nature of the work will not admit of that, they should be strapped or wired, so that they cannot move during the brazing process. If driven together, the work should fit fairly well, because if the joint is too loose the brass will not stay in, the job will look "sloppy" and there will be no real strength to the joint. There is but little danger in making too tight a fit, as the brass will run into the joint where there is apparently no room for it to go.

Holding the Work while Brazing

To hold the parts together while brazing, drill a hole through them with a No. 29 drill, and use an 8d wire nail for a pin. This makes a good pin for any work up to 2 inches diameter or its equivalent. This does not add materially to the strength of the joint, but is used mainly to hold the parts in place while being brazed.

After pinning, paint the job again with a mixture of brazing compound and alcohol—"charging" it is termed by the brazer—and also paint the work one-half inch from each side of the joint with a mixture of black lead and machine oil.

* Address: 3 Fox St., Bridgeport, Conn.

This confines the flux to one place, and also keeps the spelter from flowing away to where it is not needed, as well as saving the spelter and the work and rendering the latter much easier to clean. The work can now be put into the fire or to one side to dry. When treated in the manner described, the work can stand any length of time before brazing, as long as it does not get dirty or rusty.

Heating

Gasoline, coal, oil or gas can be used for heating, but gas is by far the best on account of the cleanness of the fire, although the others will do nearly as well, with a reduced fuel cost. There is, however, at least one brazing forge on the market that will effect a saving in gas, and still turn out good work. It is a simple, cheap, gas-saving forge and will pay for itself in a very short time by the economical use of the gas.

In building up around the work, use plenty of fire-brick to confine the heat and thus save the fuel, and fill the bed of the forge with bits of coke or broken fire-brick, (coke is better) to reflect the heat on the under side of the work. After the forge has been prepared properly, place the heavy part of the job in the fire so that it will get hot as soon as the rest of the work, and then slowly heat to a dull red color. Now take the brazing wire, hold it in the flame so as to heat it as near as possible to the melting point without melting it; then dip the wire in a mixture of the spelter and borax or a brazing compound, and apply to the joint. As the flux and spelter melt (borax and brass), turn the work so that the former will run to all parts of the joint, and while still turning the work, remove it from the fire and keep in motion until it "sets;" then lay it to one side to cool in the air. A job that is too large to be handled in this manner, may be cooled by allowing the air blast to strike the work.

Almost any ordinary wrought-iron or steel job can be brazed by heating it to a bright red color. Cast iron requires a bright yellow, and brass or copper will braze at a dull red. By using a softer grade of spelter, thereby lowering the "melting" temperature, and taking precaution to thoroughly melt the wire and spelter, a better braze will be the result. Excessive heat injures the brass by destroying the zinc properties that are contained in it. If the work is in a hurry, and especially if there is no good means of cleaning it, the piece can be dipped into a pail of soapy water while it is still hot. This will start the scale and render the work far easier to finish.

Materials

The wire used for brazing should be of special brass, intended for brazing; don't use any old piece of wire that is lying around the shop, and then wonder why it doesn't "stick." Brass wire ⅛ to ¼ inch in diameter, according to the size of the job, is the easiest to handle.

Test

A joint well cleaned and well brazed, will stand a strain nearly equal to the tensile strength of the metal itself. A machine-steel collar with a one-inch hole, brazed onto a piece of cold-rolled steel, stood a test of 10,000 pounds without a sign of giving way. A cast-iron joint, when put through the proper brazing process, will give way on either side of the joint before the joint itself will move.

Cleaning the Work after Brazing

There are several methods of cleaning the work after brazing. If a sand blast is available, use it, as it has no equal for that purpose. The next best method is "pickling" in a weak solution of vitriol and water; about one quart of vitriol to a barrel of water makes a good "pickle." This is not as good a method as the sand blast, especially for tube work, as any acid left in the tube eats the metal and weakens the joint. The sand blast leaves the work clean and ready for the file, and also shows up all the imperfections in the brazing. An old-fashioned method of cleaning the work is as follows: When the work is nearly cool, dip it in a pail of soap suds; this loosens the flux and does not harden the metal. It is not recommended as good practice.

Cost

When work is done on the premium or piece-work basis, the cost can be made very low. As high as eighteen hundred to two thousand joints can be brazed in a day of ten hours, and ordinary automobile work can be brazed at a cost of fifty cents per hundred pieces for small work, and as hign as four or even six cents per joint for the larger work.

Dip Brazing

Dip brazing may be practiced on certain classes of work and at one time was used extensively in the bicycle trade. The cost of the work is far lower, and the cost of cleaning is trifling, the brazing being done with a torch. The main difference between this and ordinary brazing is that the work is dipped into the spelter while the latter is in the liquid state.

Cast-iron Brazing

Almost any kind of a broken cast-iron joint can be brazed, and if well done is stronger than it was before breaking. The broken jaw of a 4½-inch bench vise, brazed some two years ago, has been in constant use ever since and shows no signs of giving out.

To make a good job, first heat the work to a dull red; this takes the dirt and grease out of the pores of the metal. Next clean the work with the sand blast, if available, or with a wire brush, and then apply the brazing powder to the broken surface of the work. This leaves the iron in a condition to take and absorb the spelter. Now fasten the broken parts firmly together, either by putting in a screw or holding them together with a twisted wire. When firmly bound, place the work in the fire and heat to a bright yellow color, in fact, almost to the melting point, and apply the brazing compound; then shut off the gas and allow it to cool without moving. There are several cast-iron brazing compounds on the market, but the method used in brazing is practically the same with each.

Brazing Brass and Copper

Although the process of brazing brass and copper, or as it is called by jewelers, "hard soldering" can be done at a lower heat than iron or steel work, still it calls for a higher degree of skill on the part of the brazer, as the spelter used will melt at a point but a few degrees less than that of the melting point of the brass that is being brazed. There are an endless number of spelters used for this work, but a mixture of 50 parts copper and 50 parts zinc will make a spelter that can be used on either "low" brass or copper, and with the addition of 6 or 8 parts silver, it also makes a good spelter for "high" brass.

A well-known silver solder used by the jewelry trade is a mixture of 70 parts silver and 30 parts copper, but for a small job a silver dime or quarter can be used, as they contain the correct proportions of silver and copper. Sal ammoniac will be found to give the best satisfaction for a brazing flux for work of this kind, and also has the advantage of always being at hand.

While it is important that brass work should be well cleaned, it need not be sand blasted as is the case with steel or cast iron. The cleaning process can be a dip or wash, and still give good results A dip composed of 1/3 nitric and 2/3 sulphuric acid, well mixed in an earthen vessel, will clean a brass or bronze, and leave it in good shape to be brazed; the same dip can be used to remove the scale after brazing.

To do a good job of brass brazing, clean the work thoroughly by dipping it the same as you would for a steel job, and have the brass a good fit in the work. If it is not a good fit, the brass will not stay in, and it cannot be "staked up" the same as you would with a steel job. Don't have the blast too hot. Watch the job closely, and when it shows the first tinge of red, put on your spelter; as this melts, take the job from the fire and let it cool off in the air. Do not cool it off too quickly as the sudden contraction of the metal will start the brazing.

To remove the scale, "pickle" for ten or fifteen minutes in a nitric and sulphuric dip as before described. There are a few points to look out for, and one is not to overheat the work; give it time enough to heat gradually so as to melt the spelter properly.

MILLING, CROSS-DRILLING AND BURRING ATTACHMENTS—2

APPLICATION TO THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

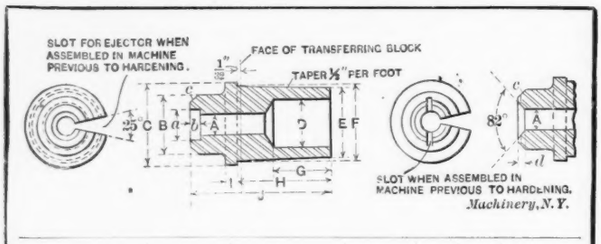
By DOUGLAS T. HAMILTON*

The method of holding the screw when presenting it to the saw is important, so that a description of the slotting bushings used in connection with the screw-slotting attachment will be given. Other devices of a special nature, such as, hexagon-head locating devices, slabbing attachment, spindle-indexing arrangement, cross-slide sawing and cross-slide slotting attachments, will be fully described in the following:

Slotting Bushings

In Table I is shown the standard form of slotting bushings used for holding fillister- and flat-head screws. The type of slotting bushing used for round- or button-head screws is similar to that shown for the fillister, except that in some cases

TABLE I. PROPORTIONS FOR SLOTTING BUSHINGS


SLOT FOR EJECTOR WHEN ASSEMBLED IN MACHINE PREVIOUS TO HARDENING.
FACE OF TRANSFERRING BLOCK
TAPER ½" PER FOOT
25°
82°
SLOT WHEN ASSEMBLED IN MACHINE PREVIOUS TO HARDENING.
Machinery, N.Y.

Mch. No.	A	B	C	D	E	F	G	H	I	J
00	1/16 to 3/16 3/16 to 1/4	5/32 1/2	9/16 9/16	1/4 5/16	0.450 0.450	0.476 0.476	1/2 1/2	11/16 11/16	1/16 1/16	1 1
0	1/4 to 1/4 1/4 to 5/8	1/2 11/16	11/16 11/16	5/16 7/16	0.600 0.600	0.631 0.631	9/16 9/16	3/4 3/4	1/16 ..	1 1/4 1 1/2
2	3/16 to 5/16 5/16 to 1/2	5/8 5/8	7/8 7/8	9/16 9/16	0.750 0.750	0.792 0.792	5/8 5/8	1 1	1/8 ..	1 1/2 1 1/2

the bushing is not counterbored for the head of the screw. The proportions for slotting bushings for the various sizes of Brown & Sharpe automatic screw machines are also given in Table I. The diameter of the hole *A* governs the diameter *B* of the front end of the bushing, and also the hole *D*. These sizes, of course, pertain only to bushings for standard screws, the slotting bushing being made to suit the work as desired. The diameter *A* should be made from 0.001 to 0.0015 inch larger

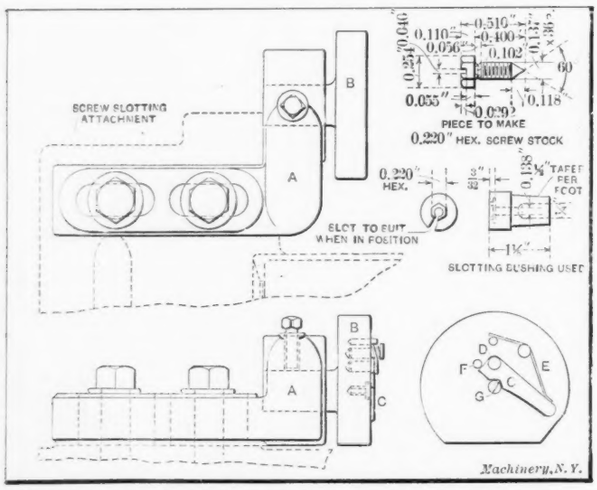


Fig. 8. Device for Locating Hexagon-head Screws in the Slotting Bushing

than the screw diameter, while the diameter *a* should be made from 0.002 to 0.003 inch larger than the diameter of the shoulder or head of the screw, as the case may be.

When a bushing is to hold a shouldered screw, and when the length of the shoulder is greater than or equal to the diameter of the shoulder, the diameter *A* is made to fit the body of the shoulder instead of the body of the threaded part of the screw. When the length of the shoulder is less than the diameter, the bushing is made to fit both the shoulder and the body of the screw. The screw head should also fit in the counterbored hole in the bushing. The distance between the shoulders

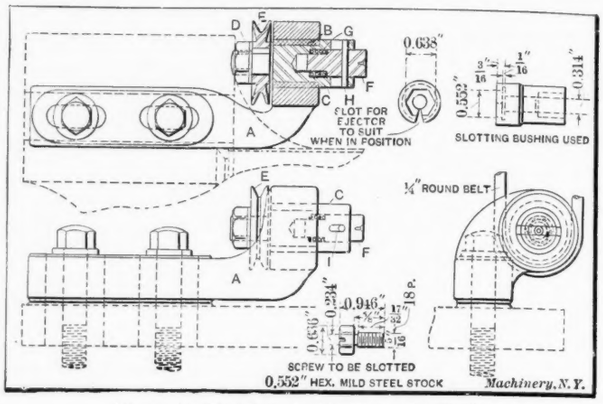

SLOT FOR EJECTOR TO SUIT WHEN IN POSITION
SLOTTING BUSHING USED
¼" ROUND BELT
SCREW TO BE SLOTTED
0.552" HEX. MILD STEEL STOCK
Machinery, N.Y.

Fig. 9. Another Hexagon Screw Locating Device

on the screw should always be less than the distance between the shoulders in the bushing, so that the screw head alone will bear against the shoulder in the bushing. The distance *d* on the bushing for flat-head screws should be made equal to ½ the thickness of the head, when the body of the screw is greater than ¼ inch. When the body of the screw is less

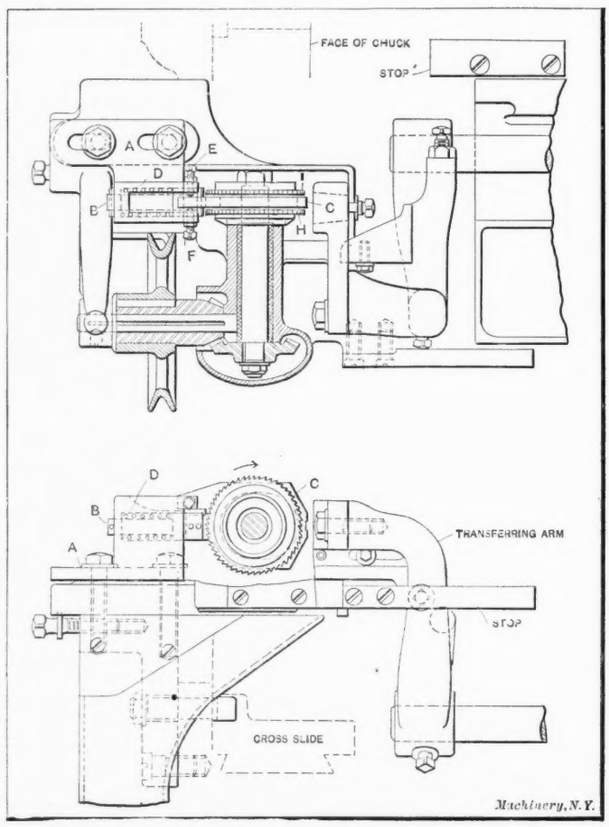


Fig. 10. Slabbing Attachment used on Screw-slotting Attachment

than this, the head, as a rule, is usually sunk the full depth in the slotting bushing. The corner *c* should only be beveled when the diameter of the counterbored hole *A* will permit, otherwise the corner should not be beveled, but rounded slightly.

Slotting bushings are usually made from tool steel, and are not hardened until the cams have been tried out and the whole job is completed. The slot for the ejector is cut before the bushing is inserted in the transferring block, and the slot for the saw in the bushing for flat-head screws is cut when the bushing is held in position in the transferring block. When a bushing is to hold a fillister-head screw, as a rule the

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slotting saw does not touch the bushing at all, the depth of the counterbore *b* in the bushing being slightly less than the difference between the depth of the slot and the thickness of the head of the screw. The dimension *F* is not taken at the shoulder of the bushing, but is the largest diameter of the taper hole in the transferring block. This allows the bushing to drive tightly into the block, 1/32 inch being allowed for driving. It is customary, however, to make the dimension *F* slightly larger than necessary and fit it into the block when trying out the job. The bevel in the bushing for holding flat-head screws is made to suit the included angle of the head, the angle shown being that adopted by the A. S. M. E.

Slotting Hexagon-head Screws

When the slot in the head of a hexagon screw has to bear some definite relation to the sides of the head, it is necessary that the screw be located in an exact position in the slotting bushing. The bushing for holding the screw has usually an impression in it, which fits the hexagon head, but it is another matter to get the screw to locate properly in the bushing. If the bushing is forced onto the work when it is attached to the bar, ten chances out of one the screw will not be located in the hexagon, but the corners will be torn off, and the screw broken off before it is severed from the bar. To obviate this difficulty, some device must be employed for locating the screw in the bushing, after it has been severed from the bar.

A device which is used for locating a hexagon-head screw in the slotting bushing is shown in Fig. 8, where the screw and slotting bushing are also shown. This device consists of a cast-iron bracket *A*, which is held on the slotting attachment, being retained in position with the same screws that hold the slotting attachment. Held in the boss of the bracket *A*, is a holder *B* to which is attached the locater *C*. This consists of a piece of sheet steel about 1/16 inch thick, held on a pin *D* and free to swivel. Pressing against this locater is a spring *E* which forces the locater against the stop pin *F*. A screw *G* acts as a stop, being adjusted in or out as desired to locate the head of the screw against the shoulder in the bushing, and also acting as a stop for the locater *C*.

In operation, as the screw is removed from the chuck by the slotting bushing, the arm, in ascending, is brought to dwell in an intermediate position, and is then advanced towards the locater *C*. As this locater is beveled, the screw forces it up, and the action of the spring turns the screw around in the bushing, so that the hexagon head is located properly, the arm at the same time advancing and forcing the screw in to the desired depth. The method of designing the transferring cam to dwell in this intermediate position will be described in connection with the burring attachment, in a future article.

In Fig. 9 is shown a device for locating hexagon-head screws in the slotting bushing which differs somewhat in principle from that shown in Fig. 8. This device consists of a cast-iron bracket *A*, which is fastened to the slotting attachment as previously described. The bracket is provided with a phosphor-bronze sleeve *B*, in which a spindle *C* is free to rotate. Keyed to the spindle *C*, and held by a nut *D*, is a grooved pulley *E*, which is driven by a ¼-inch round belt from the overhead works. Held in the spindle *C* is a spring plunger *F*, which is pressed forward by an open-wound spring *G*. This spring plunger is prevented from rotating by a pin *H*, which fits in an elongated slot *I*, cut in the spindle *C*.

In operation as the slotting bushing lifts the screw from the chuck, the arm dwells in an intermediate position, travels forward and presses the screw against the rotating plunger *F*. As this plunger is driven slowly, and as the arm is advanced, the friction between the head of the screw and the plunger rotates the former. On the continued forward travel of the arm, the screw is located correctly in the bushing and forced in to the correct depth. The screw and the slotting bushing used for holding it are shown in the illustration, where the principal dimensions on the slotting bushing are also given.

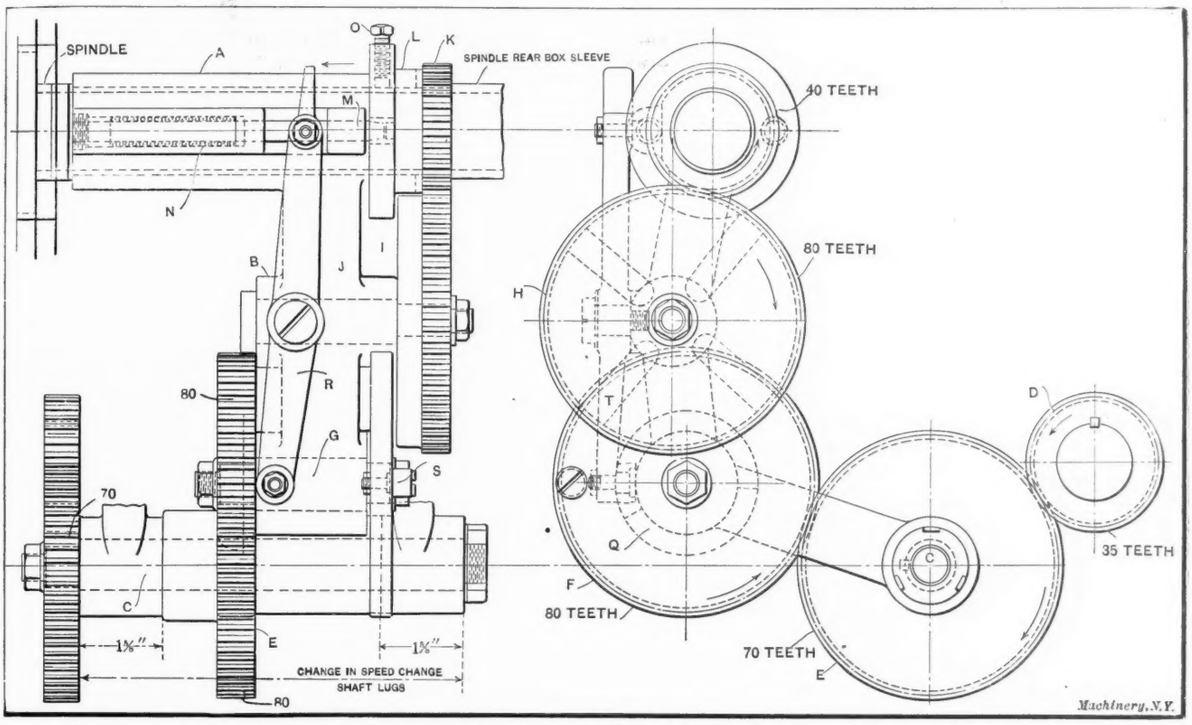

Fig. 11. Attachment for Indexing the Main Driving Spindle of a Brown & Sharpe Automatic Screw Machine

Slabbing Attachment

A slabbing attachment which is fastened to the ordinary screw-slotting attachment is shown in Fig. 10. The screws which hold the slotting attachment to the frame of the machine are removed and the slabbing attachment *A* is seated on the top face of the base of the slotting attachment. The screws are again inserted, and the slabbing attachment fastened in position. The main body of the attachment is an iron casting, and a boss on it is bored out to receive a plunger *B* to which is attached a guide or ejector *C*. The plunger *B* is riveted to this guide member *C*, and a coil spring *D* is located behind the shoulder of the plunger to keep it out.

Two set-screws *E* and *F* with lock-nuts are provided for guiding the member *C*. This guiding or ejecting member *C* has an elongated hole bored in it, fitting over the saw arbor, so that the ejector can be forced back by the piece when it is being advanced to the slabbing saws by the transferring arm. The front face of the ejector *C* is knurled, so that the piece is prevented from rotating in the slotting bushing when the saws *H* and *I* commence to cut. This attachment is driven

in the same manner as the ordinary screw-slotting attachment, and the bushing in which the work is held while being slabbed is also of a similar type. Of course, the exact shape of the bushing would depend entirely on the shape of the work. In the lower view, the driving mechanism has been removed to show the slabbing attachment more clearly.

Spindle Indexing Device

A device which converts the Brown & Sharpe automatic screw machine into a milling machine is shown in Fig. 11. This device was designed for making a special piece, which is shown at *A* in Fig. 12, where the cams for making the piece are also shown. Before taking up the making of this piece it will be necessary to describe the indexing device.

To apply this device, the pulleys *A* and *B* shown in Fig. 13 are removed, as is also the clutch mechanism. The outer sleeve *A* of the attachment shown in Fig. 11 is then slipped over the regular spindle. This sleeve is cast integral with a bracket *B*, the lower end of which is located on the shaft *C* shown in Fig. 13. This shaft is part of the belt-shifting arrangement which is used for obtaining two different speeds for the spindle when threading steel. The attachment is driven from the rear driving-shaft by the ordinary gears *D* and *E* which drive the belt-shifting arrangement as shown in Figs. 11 and 13. A 35-tooth gear *D* is placed on the driving shaft, which meshes with a 70-tooth gear *E* located on the shaft *C*. These gears drive an 80-tooth gear *F* on the stud *G*.

A trip and indexing mechanism somewhat similar to that used on the turret, is used here for indexing and locking the spindle. The 80-tooth gear *H* meshes with a 40-tooth gear *K* keyed to the sleeve *L* held on the spindle. This sleeve has two holes drilled in it, in which the plunger *M* fits. A spring *N* behind this plunger keeps it in contact with the sleeve *L*. This

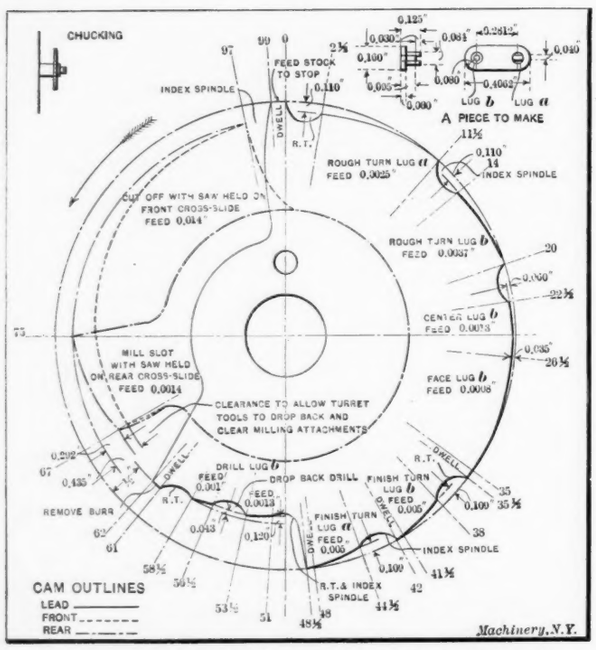

Fig. 12. Lay-out of a Set of Cams for Making a Piece requiring the Indexing of the Work-spindle

sleeve *L* is fastened to the main driving-spindle of the machine by a set-screw *O*. This attachment is operated as follows:

The dog on the drum held on the front cam-shaft, is set to trip the lever, which, when tripped, operates the tooth-clutch *P* Fig. 13, thus rotating the rear driving-shaft. As the rear driving-shaft rotates at 180 R. P. M., the gear *D* will revolve at the same speed, while the gear *E* will revolve at 90 R. P. M., and will transmit a speed of 90 R. P. M. to the gear *F*. This gear *F* carries a cam *Q*. and a roller attached to the lever *R* runs on this cam. Then when the dog trips the lever, the driving-shaft rotates, thus driving the gears, which in turn rotate the cam *Q*. As the cam *Q* is rotated, the arm *R* is moved in the direction indicated, which action withdraws the pin *M* from the bushing *L*. Now at the same time that the pin *M* is withdrawn, the roller *S* comes in contact with the slot *T* in disk *I* held on the stud *J*, thus rotating the disk on one quarter turn. This disk is provided with four slots *T*, and as this indexing device requires to be indexed 180 degrees to bring each part of the piece into position, the disk *I* is moved two spaces before another dog on the drum trips the lever that disengages the tooth-clutch *P*, Fig. 13. It can be seen, therefore, that with this arrangement the spindle is indexed in a similar manner to the work arbor of an automatic gear-cutter.

Referring to Fig. 12, it will be seen that the piece to be made has two lugs on it designated *a* and *b*. The stock from which

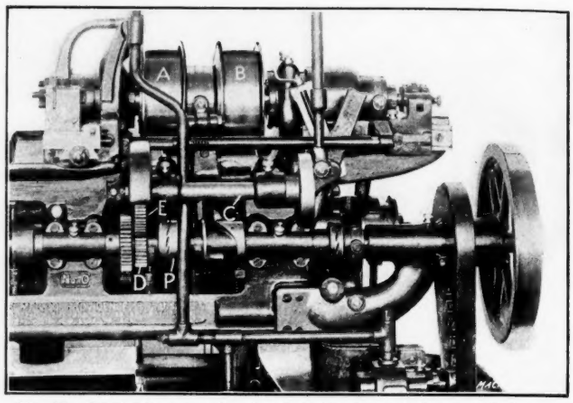

Fig. 13. Illustration showing the Location of the Indexing Attachment

this piece is made is of special shape, so that its outside circumference does not require to be finished; the lugs *a* and *b* are to be formed, drilled and slotted. The turning of these lugs presents a problem which is different from those ordinarily encountered on the Brown & Sharpe automatic screw machine. The work is not revolved at all, being indexed only to bring the stock into position for forming the two lugs. To turn these lugs, the turret is packed out an amount equal to one-half the distance between the center of the two lugs, and drilling attachments are used in the turret for holding hollow mills and drills used for turning and drilling the lugs. The order of operations for making this piece is as follows:

Order of Operations	Revolutions	Hundredths
Feed stock to stop	4½	1
Revolve turret	12	2½
Rough turn lug *a* with hollow mill held in drilling attachment, speed 684 R. P. M. at 0.0025 inch feed	43	9
Index spindle and revolve turret	12	2½
Rough turn lug *b* with hollow mill held in drilling attachment, speed 684 R. P. M. at 0.0037 inch feed	28	6
Revolve turret	12	2½
Center and face lug *b* with centering tool held in drilling attachment, speed 684 R. P. M. at 0.0013 inch feed to center and 0.0008 inch feed to face	62	13
Revolve turret	12	2½
Finish turn lug *b* with hollow mill held in drilling attachment, speed 684 R. P. M., at 0.005 inch feed	19	4
Index spindle	12	2½
Finish turn lug *a* with hollow mill held in drilling attachment, speed 684 R. P. M., at 0.005 inch feed	19	4
Revolve turret and index spindle	12	2½
Drill hole in lug *b* with drill held in drilling attachment, speed 3555 R. P. M. at 0.0013 inch feed	12	2½
Pull out drill to remove chips	14	3
Finish drill hole in lug *b* with drill held in drilling attachment, speed 3555 R. P. M., at 0.0011 inch feed	9	2
Revolve turret	12	2½
Remove burr and broach with tool held in floating holder	4½	1
Clear	24	5
Mill slot in lug *a* with special milling attachment held on rear cross-slide, speed 400 R. P. M., at 0.014 inch feed	(26)	(8)
Cut-off with special milling attachment held on front cross-slide, speed 480 R. P. M., at 0.014 inch feed	143	30
Index spindle	10	2
	476	100

Cross-slide Slotting Attachment

The special slotting attachment designed for cutting the slot in lug *a* shown in Fig. 12 is shown in Fig. 14. This attachment consists of a block *A*, the base of which is held to the rear cross-slide by a bolt and nut *B* and *C* as shown, the former fitting in the T-slot in the cross-slide. The spindle *D* passing through the casting which is bushed with a bronze sleeve, has attached to it a bevel gear *E*, meshing with a bevel gear *F* keyed to the vertical spindle *G*. This vertical spindle *G* also runs in bronze bushings. The pulley *H* is keyed to the rear end of shaft *D* and is held to it by a nut and washer as shown. A round belt which passes over a grooved pulley held on the countershaft, drives this pulley *H*, which, in turn, drives the slotting saw *I* held on the lower end of the vertical spindle. Adjustment is provided for the slotting

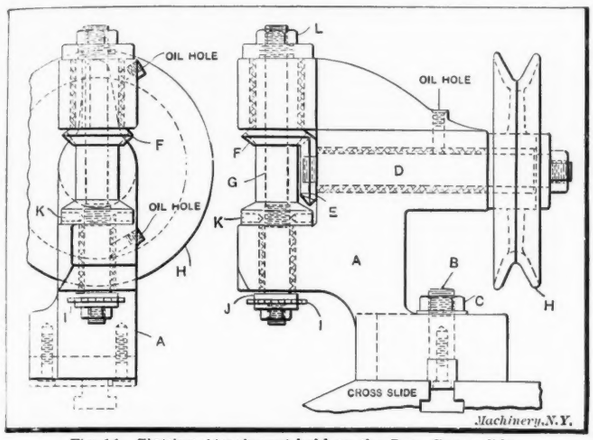

Fig. 14. Slotting Attachment held on the Rear Cross-slide

saw *I* by varying the thickness of the washer *J*, and also by means of the adjusting nuts *K* and *L*. Gear *F* has a shank which fits in the upper member, so that the spindle *G* can be adjusted without affecting the position of this gear.

Cross-slide Sawing Attachment

The attachment which is used for cutting off the piece shown at *A* in Fig. 12 is shown in Fig. 15. This attachment is held on the front cross-slide, and consists of a holder *A* somewhat similar to the ordinary holder used for the circular form tools, and is also held to the cross-slide in a similar manner.

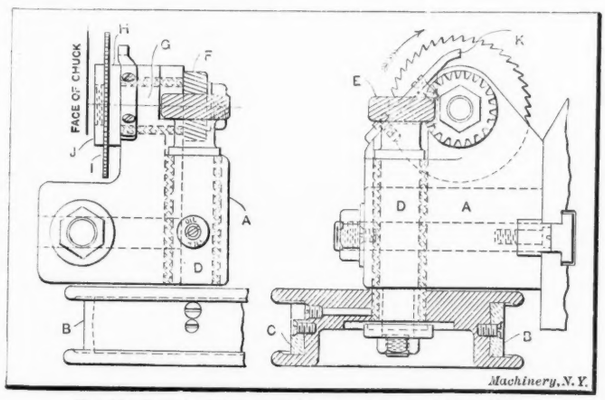

Fig. 15. Sawing Attachment held on the Front Cross-slide

A three-quarter inch flat belt, which passes over a pulley fastened to the countershaft, drives this attachment through the pulley *B*. This pulley *B* has a leather strip *C* fastened to it which increases the friction and gives a more positive drive to the cutting-off saw. The pulley *B* is keyed to a shaft *D*, and also held to it by a nut and washer as shown. The shaft *D* which passes through a bronze bushing held in the holder *A* has a helical gear *E* cut on its forward end. This helical gear meshes with a mating gear *F* held on the cutter spindle *G*, which is located at right angles to the spindle *D*. The spindle *G* fits in a bronze sleeve held in the holder *A*, and is provided with a shoulder *H* against which the slotting saw *I* is held by the nut *J*. The guard *K* is used to prevent the work from springing away from the saw when almost cut off.

VANADIUM IN CAST IRON

In a paper read before the American Foundrymen's Association, Mr. G. L. Norris stated that an addition of 0.1 per cent of vanadium to cast iron necessitates an increase in the selling price of from three-quarters to one cent per pound; hence the use of vanadium in cast iron is confined to such classes of work as can stand a material increase in cost in return for the special qualities obtained. Vanadium increases the strength of the cast iron to which it is added from 10 to 25 per cent. Vanadium also gives an element of toughness to cast iron which is very apparent in machining the castings. This toughness, together with the uniform fineness of grain, due to the even distribution of graphite, makes vanadium cast iron superior for such purposes as gas and steam engine cylinders, valve and piston bushings, piston rings, glass bottle molds, etc.

Three or four years ago the New York Central lines equipped one of its locomotives with a pair of cast-iron cylinders containing vanadium. The performance of this pair of cylinders over a test period of about two years was so satisfactory that 500 or more locomotives on these lines are now equipped with similar cylinders. The test of the original pair demonstrated that over twice the normal mileage of ordinary cast-iron cylinders could be obtained with such cylinders before reboring. The loss in casting these cylinders was extremely low, no cylinders being scrapped at all for the first 183 locomotives ordered. The same results have been reported by a builder of large gasoline engines for marine use. In this particular case, the number of cylinders formerly lost when tested after machining, was excessive, due to porousness of certain sections.

Piston rings and cylinder and valve bushings of cast iron with vanadium have been thoroughly tried and adopted by a number of leading railroads on account of the greatly increased length of service obtained. A very interesting application of vanadium has been for glass bottle molds. These are chilled castings, and are usually covered with engraving. The iron has to be clean, close and uniform in grain, machineable, and take a good polish. The first cast-iron bottle molds of this kind were made a little over a year ago and proved to have a longer life; it was also found possible to increase the speed of the bottle machines, as the glass did not appear to stick to these molds to any extent. This can be readily accounted for by the uniformity of the grain and freedom from mottled spots.

The field of application for vanadium in bearing metals has recently been receiving considerable attention, and already some very interesting results have been obtained. One of the most notable of these has been the performance of a vanadium bronze bearing metal in a step bearing of a grinding machine. The load on the bearing of this machine ranges between 1000 and 1100 pounds per square inch, and the great difficulty heretofore has been to secure a metal that would stand up under this pressure, and give satisfactory results with regard to wear and friction. A number of bearing metals of high reputation have been tried out in this machine, and some of them have only lasted fifteen to sixteen hours. The vanadium bronze bearing metal tested was based on the standard P. R. R. car box bronze mixture, with an addition of about 0.05 per cent vanadium. Bearings from this mixture have been in service for a year with entire satisfaction. The amount of wear on these bearings has been very small, and, as a matter of fact, the operators of the machines have been unwilling to have the bearings taken out for measurement as they are entirely satisfied with their performance.

As a result of the very satisfactory performance of these bearings, the mechanical department of this same works has recently started tests of standard babbitt metal with the addition of a small quantity of vanadium. This babbitt has only been in service about a month in electric motors, but it is showing up very satisfactorily, and promises to prove superior to the standard babbitt.

* * *

Don't forget that gasoline is a good lubricant for lapping.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on.

OCTOBER, 1911

PAID CIRCULATION FOR SEPT., 1911, 25,446 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

ARTICLES TO MANUFACTURE

We are often asked to suggest articles that can be manufactured with a comparatively simple shop equipment. Many mechanics who desire to start in business for themselves are unable to find anything to make that seems likely to be profitable. If they have an article that will sell, the problem of securing capital to promote it is generally easy of solution.

Readers of MACHINERY will oblige us by calling attention to articles that would be suitable for small shops to manufacture, especially if the product is something that should be used in machine shops. The desirable characteristics of such articles are: potential market, simplicity, novelty and reliability. A patented article is preferable to one that is not protected, as the investment of capital is more easily secured for its manufacture.

* * *

"IT CAN'T BE DONE"

Paradoxical as it might seem, there is truth in the saying that it is generally the man who does not know that a thing can't be done, that does it. This is especially true in the engineering and scientific field. Engineers and men of science often assume as axioms that certain things are impossible, and they never try to demonstrate the contrary. They hardly ever think of the means by which these apparently impossible things could be accomplished. It is the man who does not know—that is, the man who is not imbued with the idea of the impossibility of accomplishing a certain object—that goes ahead, tries it, and often succeeds. Many examples could be cited which prove this to be true. However, it is necessary to recall but one, as this one is at the present time so prominently before the public eye as to be appreciated by everybody. Only a few years ago one of the great American scientists, Prof. Simon Newcomb, stated that successful flights with a heavier-than-air machine were impossible and he proved to the satisfaction of a good many other scientists and engineers that his contention was scientifically correct. Yet men who knew very much less of science than Prof. Newcomb—men who did not know that it was impossible to fly—accomplished the feat.

In the machine building business it is not unusual that a young enthusiastic mechanic proposes to do something that has never been done before, and old level-headed men will tell him half-pityingly, half-sarcastically that "this thing can't be done." But the young man does not know that it cannot be done, so he goes ahead, if he can do so without overstepping the authority of the men above him, designs his machine or device, and it does the work. No doubt it is many times better to be too conservative than to rush heedlessly into a new and uncertain undertaking, but nevertheless we should be careful about stating definitely that it is impossible to accomplish certain things. Many times great opportunities are lost by checking the enthusiasm and the ability of an inventive mind with a repetition of that time-worn expression: "It can't be done."

* * *

PERSONALS AND OBITUARIES

Readers of MACHINERY will confer a favor by promptly sending to the editor personals and obituaries of men prominent in the machinery trade. We particularly wish notices of changes made by men in responsible positions, such as foremen, superintendents, general managers, chief draftsmen, etc. When such changes are made, we are glad to notice them in the personal column of MACHINERY. These notices are not printed simply to please the persons mentioned; they are regarded as items of news, as useful in their way as any of the other news items published.

Obituaries of men who have accomplished mechanical work worthy of note are always desirable. Information of value is often conveyed in accounts of the lives of men who have passed away, and the wide-awake progressive mechanic is benefited by knowing something of the history of the machines and methods that he uses in manufacturing. We shall be glad to receive personals and the obituaries of prominent mechanics from any reader.

* * *

SIMPLICITY OF MANUFACTURING METHODS

Manufacturing methods may be roughly divided into two general classes as regards equipment, the first being that in which standard machines and tools and simple methods are used, and the second that in which special machines, tools and processes have been developed to cheapen the cost and enhance the quality of the product.

One of the surprises that often awaits the visitor to manufacturing plants is finding simple methods and tools used in a class of manufacturing that he had supposed required complicated methods and machines for economical production. On the other hand, some of the products on the market, which to the uninitiated seem very simple to make and which *can* be made in a simple manner, are manufactured with costly machinery and often by methods that are regarded as trade secrets.

Visiting manufacturing plants is educational in the highest degree, but few can afford the time and money required to make extensive inspection trips. The next best means of obtaining such valuable experience and at low cost is reading MACHINERY. The knowledge of how things are made outside of one's own realm may be extremely valuable to the mechanic who sometime has to handle materials or turn out products of a similar nature. If given the problem without having knowledge of the methods commonly employed, he might spend much time and money in developing costly ways and means imagined to be necessary for success. On the other hand, he might blunder in assuming that a simple product could be produced in a simple manner with cheap machines, and find, too late, that he had made a costly mistake.

As a rule, the larger the output of a simple product, the more complicated are the machinery and processes employed. Take, for example, the sewing machine needle, which is as simple a thing almost as can be imagined. One concern in the United States has nearly monopolized the manufacture of machine needles through its development of peculiar machinery and methods that produce high-grade needles very cheaply. If a thing is made in comparatively small numbers, the methods and tools used are usually simple, unless a part absolutely requires an unusual process to produce it successfully.

ATWOOD'S AEROPLANE FLIGHT

The aeroplane flight of Henry Atwood from St. Louis to New York, begun August 14, finished August 25, and covering a distance of 1265 miles, is a remarkable feat and one of significance as to the future of the aeroplane. It does more to demonstrate the practicability of the aeroplane for certain services than all the fancy flights and manœuvers of daring aviators who have risked life and limb in their performance. Atwood's aviation exploits have been marked with a sober regard for safety of himself and machine. Nine-tenths of the accidents that have befallen aviators have been due to freak exhibitions, spiral dips, swoops and curves that throw enormous stresses on the engines and framework of aeroplanes, because of the gyroscopic effect of the revolving masses. When aviators abandon dare-devil exhibitions, height flights and other foolhardy "stunts," aviation will undoubtedly progress much more rapidly in the estimation of the sober-minded public than it has through the freak flights of the last two or three years.

* * *

COMPLICATED VS. SIMPLE MACHINE DESIGNS

Some time ago we had the opportunity of inspecting a new machine designed to perform certain work more rapidly than by the ordinary means. The machine was the first development of its kind and the designer looked upon it with considerable pride. A casual observer, however, could not refrain from thinking that a machine consisting of such a mass of levers, handwheels, adjustments and slides is hardly the thing to put into the hands of the ordinary machine operator. Many a machine designer seems to entertain a certain pride in the fact that he is accomplishing his ends by means of a complicated mechanism, and will describe with eloquence and enthusiasm the wonderful harmony with which a long train of gears and levers will work. As a matter of fact, however, the most ingenious designs are the simplest ones—those that contain the fewest parts. This, of course, is recognized by everyone who has any mechanical common sense. It requires a designer of the greatest ability to bring the complicated design, which under favorable conditions will perhaps perform its work properly, down to a simple mechanism involving only a few parts and performing its work with absolute reliability. The less complicated machine is not so likely to get out of order, and if once out of order, it is much easier to put back into working condition again. There was a time when a machine with many features ingeniously combined seemed to attract the prospective customer, but that time has practically passed. At the present time it is the simple, easily operated machine that is in greatest demand. The designer with a new and brilliant idea should put as much stress upon making his design simple as upon getting it to work at all. A machine for doing nearly anything within reason can be designed by almost any fairly good designer, provided he is permitted to make it as complicated as he likes, but it is the true mechanical genius only who is able to design a simple machine to perform complex operations.

* * *

TRACKAGE OF LARGE U.S. RAILWAY SYSTEMS

The following railroad systems in the United States each have a trackage of over 5000 miles, including switches, turnouts, etc.:

Atchison, Topeka & Santa Fe	10,471.18
Atlantic Coast Line	11,426.08
Baltimore & Ohio	5,570.34
Chicago & Northwestern	9,827.31
Chicago, Burlington & Quincy	11,757.88
Chicago, Milwaukee & St. Paul	9,697.50
Great Northern	7,414.80
Illinois Central	8,255.51
Missouri Pacific	7,282.36
New York Central	13,227.64
New York, New Haven & Hartford	6,480.77
Northern Pacific	6,280.72
Pennsylvania	11,197.51
Rock Island	8,144.36
St. Louis & San Francisco	7,470.75
Southern	9,781.30
Southern Pacific	10,248.27
Union Pacific	7,177.78

PRICES OF JOB WORK PERFORMED ON MACHINE TOOLS

In order to make a satisfactory answer to a request for the rates charged by machine shops in some of the principal manufacturing centers for job work performed on planers, lathes, boring machines and other machine tools of various sizes, we addressed a circular letter to concerns in Cincinnati, Ohio, Cleveland, Ohio, Hartford, Conn., Newark, N. J., Providence, R. I., Rochester, N. Y., Rockford, Ill., and Worcester, Mass., and the following quotations are the gist of the replies received:

"The usual rate charged in Cleveland is 60 cents an hour. This rate is considered too low by many concerns, but they say that if they try to get more it results in dissatisfaction and they lose the work. We had some planing done about a year ago on a 48-inch by 48-inch by 30-foot planer driven by a 10 H.P. motor which was charged to us at $1.50 per hour."

"The machine shop proprietors in Cincinnati usually charge about 60 cents per hour for ordinary machines, although some of the larger companies charge 75 cents an hour for ordinary machines. They are, however, few in number. The usual charge for heavy machines such as large-size planers, lathes and boring machines is from $1.00 to $1.25 an hour. We think the majority of machine shops charge 60 cents an hour for ordinary machines and $1.00 an hour for heavy machines."

"The rates charged for machine work in Hartford vary considerably in the different shops. In our own case we charge from 60 cents to $1.00 per hour according to the nature of the work and size of the machine employed. We would say that the average price in and around Hartford is between 65 and 70 cents per hour."

"The rate in Newark is 60 and 75 cents and $1.00 per hour, depending upon the cost of machine and equipment doing the work."

"The usual hour rates charged for job work performed on planers, lathes, boring machines and other machine tools in Providence vary considerably throughout the different shops. The general rate for good machine work seems to run between 60 and 70 cents per hour. Very fine work, such as die work and tool work, generally runs up to 90 cents per hour. These figures have been obtained from various sources and appear to be very nearly uniform rates. Of course, these prices are likely to be affected by the quantity of the work and the promptness with which the work is paid for."

"The majority of shops doing job work in Rochester charge 75 cents per hour, although there are some cases where work is done for 60 cents, but 75 cents is the prevailing rate."

"We think that 60 cents an hour for general machining is a common charge among the job shops in Rockford. Recently to help out a concern whose factory was destroyed by fire we allowed them to use some eight or ten of our machines; among others was a planer that cost us, installed, in the neighborhood of $5000. We charged an hourly rate for the use of this machine of 60 cents. For the lathe that cost $300 or $400 the charge was 20 cents an hour."

"It is a custom of Worcester manufacturers to charge from 50 to 75 cents per hour for job work performed on planers, lathes, boring machines and other machine tools of various sizes, the exact amount depending upon the machine used and the grade of the shop. We think it safe to say that the average price in our city would be 60 cents per hour."

* * *

Experiments made at the McGill University by Mr. J. W. Evans of Bellville, Ont. apparently demonstrated that the titaniferous iron ore, which abounds in Quebec and Ontario, can be converted directly into steel by an electric process and thus made commercially valuable. Tool steel of superior quality can be produced at a cost of about 2 cents a pound. One experiment was made with a one-half ton electric furnace into which 230 pounds of ore were placed and from which 110 pounds of steel were produced. The steel was poured directly into molds and cast into lathe and planer tool shapes, which were ready for use after being hardened, tempered and ground.

TOOLS AND METHODS USED IN THE WINDSOR MACHINE CO.'S PLANT

The accompanying halftones and line engravings illustrate some interesting tools and methods used in the shop of the Windsor Machine Co., Windsor, Vt. Several of the methods and devices used in the plant of this company have been previously described in MACHINERY (see the November, 1908, and November, 1910, numbers). The present article, therefore, will be devoted to a few special tools and devices, most of which have been developed at a recent date.

Chuck for Facing Gear Blanks

The facing of gear blanks in an ordinary chuck so that the two sides become exactly parallel, is a difficult operation, and unless some special means are provided for accomplishing the desired result, it is almost impossible to obtain an accurate job. In Fig. 1 is shown a special chuck which is used for holding gear blanks while facing one side of the blank in the Jones & Lamson turret lathe. The interesting feature of this chuck is the construction of the vise jaws which are shown in detail in the halftone Fig. 2 and the line engraving Fig. 10. The gear blanks are first drilled, bored and reamed, one side being faced in the usual way. They are then clamped in the chuck shown, for facing the other side. Later they are turned, eight or ten at a time, on a nut arbor.

In Fig. 1, where the chuck is shown assembled and ready for operation, the special jaws are shown at *A*. At *B* is shown a plate which is bolted to the face of the chuck and which is trued up for each lot of gears being faced. Provided the gear blanks are clamped solidly against plate *B*, this insures that the two sides of the blanks will run true in all cases. A detail view of plate *B* is shown in Fig. 2. The jaw proper is shown at *C* in Figs. 2 and 10, and at *D* in the same illustrations is shown an auxiliary swinging jaw which is pivoted at *E* in jaw *C*. When a piece of work is not clamped in the chuck, jaw *D* is held in a normal position by spring *F* which is inserted in hole *K* in jaw *C*, and which forces together surfaces *G* on the auxiliary jaw and the jaw proper. When a gear blank is being clamped in the chuck, the points *H* of jaws *D* bear against the work, and as the point *H* is inside of the pivot *E*, with relation to the chuck, the work is forced against plate *B* instead of being lifted away from its bearing surface as is frequently the case in an ordinary chuck. When a chuck provided with jaws of this kind, and trued up as mentioned, is used, it is possible to face work within 0.0002 inch of being true.

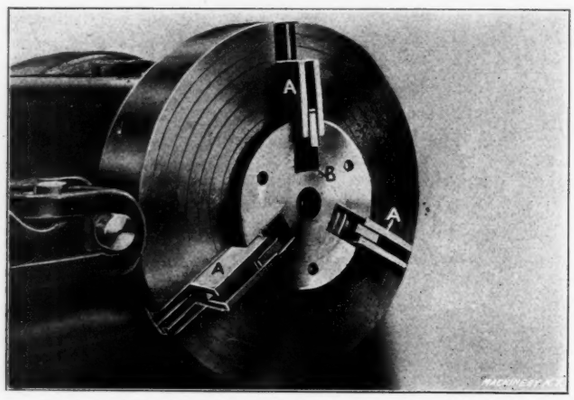


Fig. 1. Chuck with Special Jaws for Holding Gear Blanks while Facing

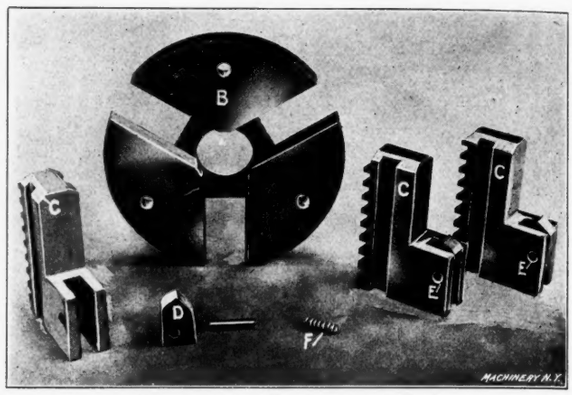


Fig. 2. Parts of Chuck shown in Fig. 1

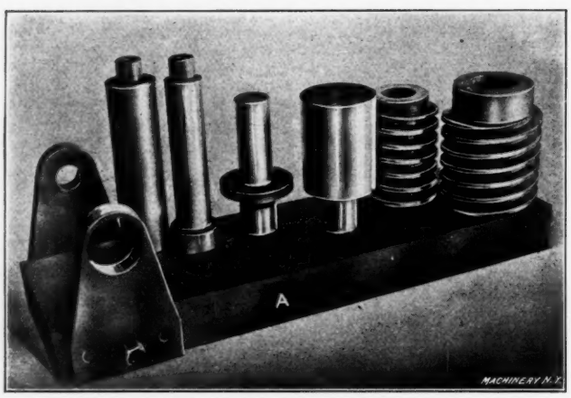


Fig. 3. Gage for Testing Worms and Worm-wheels

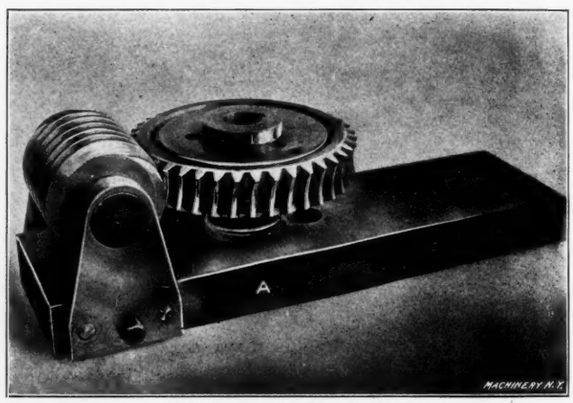


Fig. 4. Gage in Fig. 3 in Use

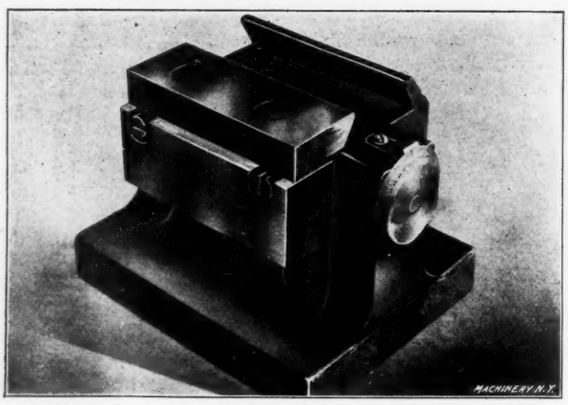


Fig. 5. Holder for Forming Tools while Grinding the Forming Surfaces

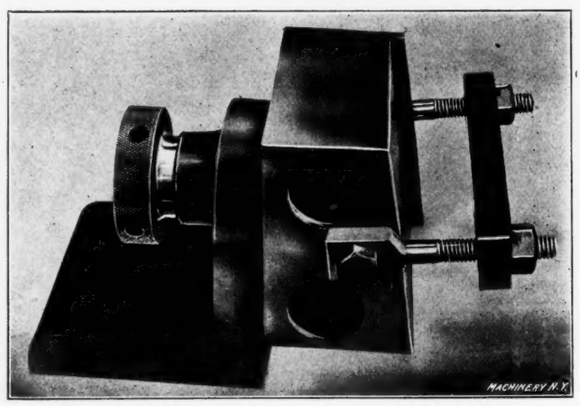


Fig. 6. Holder for Forming Tools while Grinding Top Surface

Testing Devices for Spur and Worm Gears

Figs. 3, 4 and 9 show some illustrations of testing devices or gages for inspecting spur gears and worm-gears used in the Gridley automatic machines. In Fig. 3 the worm-gear testing device is shown with its studs, arbors and master worms. As will be noticed, separate holes in base block *A* and separate studs are provided for each worm-and-gear set to be tested. The studs, holes and master worms are all plainly marked, so that it is almost impossible to make a mistake. The usual order of procedure when inspecting gears and worms by this testing device is to first test the gear in conjunction with the master worm, and afterward to test the gear again in conjunction with the worm with which it is actually to mesh. In this way a double check on the accuracy of both worm and gear is afforded. In Fig. 4 the worm-gear testing gage is shown in use, the worm-gear in this case being tested with its master worm.

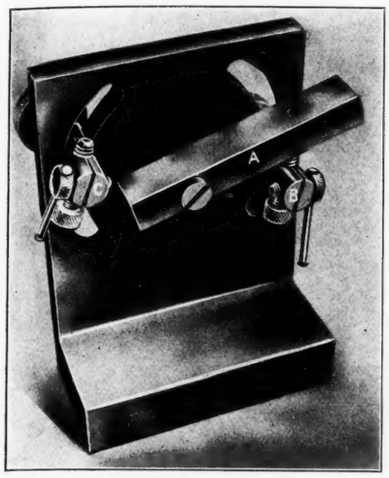


Fig. 7. Device for Truing Grinding Wheels for Forming Tools

In Fig. 9 the block used for testing spur gears is shown. In this case also one gear of a pair is first tested with a master gear and then the two gears which are to mesh are tested by running them together. Separate holes and studs are provided in this case also for each set of gears, the studs, holes and master gears being marked in the same way as already mentioned in the case of the worm-gear testing device. The gage blocks are made from cast iron and are provided with tool-steel, hardened and ground bushings for the studs upon which the gears are mounted. These studs are also made of tool steel and hardened.

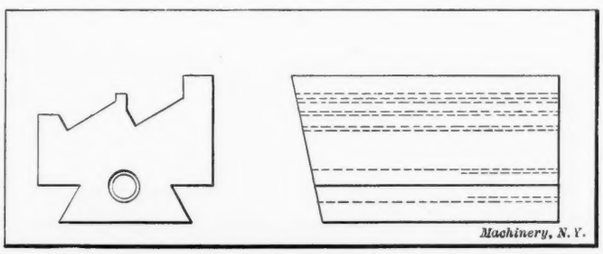


Fig. 8. Type of Tool ground in Fixtures shown in Figs. 5 and 6

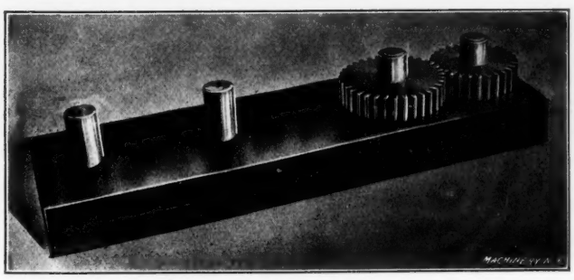


Fig. 9. Spur Gear Testing Device

The devices shown are very simple, but constitute a convenient and accurate method of inspection. While the gages are not in any way universal, they have the advantage of being "fool-proof." In interchangeable manufacturing, gages intended for but one purpose are generally preferable to so-called "universal" testing devices, as the chances of mistakes are fewer, and such mistakes as misreadings of graduations, or the slipping of some slide or part after the gage has once been set, are entirely eliminated.

Holders for Grinding Forming Tools

In Figs. 5 and 6 are shown two devices which are used when grinding the formed surfaces of forming tools used in the Gridley automatic machine. In Fig. 8 is shown a sample of the style of tools ground with the aid of these fixtures. The holders are attached to the table of a Brown & Sharpe surface grinder by means of a magnetic chuck. The device in Fig. 5 is used for grinding the shape of the formed surfaces of the forming tool, the tool being held by the dove-tail of the fixture, in practically the same way as it is held in the automatic machine when in use. As indicated in the halftone illustration, the holder can be swiveled to any angle in order to accommodate the grinding of the various surfaces of the tool. The holder in Fig. 6 is intended for grinding the flat top surface of the tools.

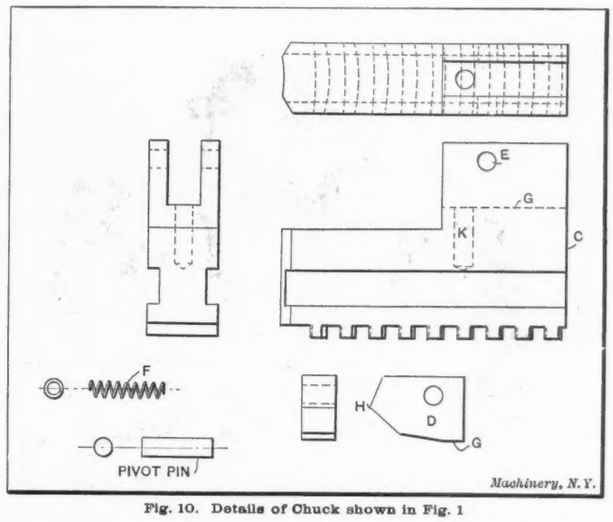


Fig. 10. Details of Chuck shown in Fig. 1

The device shown in Fig. 7 was designed for truing the sides of the wheel for grinding forming tools for bevel gears and other work of similar nature, on which a double angle has to be formed. A diamond is held in a flat holder which slides on the guide *A*, the position of this guide being governed by the location of the adjustable stops *B* and *C*. After the stops have been set so as to give to the wheel the desired angles, it is only necessary to turn the guide from the one to the other in order to true the wheel to the correct shape as often as desired. All forming tools are ground after hardening so as to insure as great accuracy as possible.

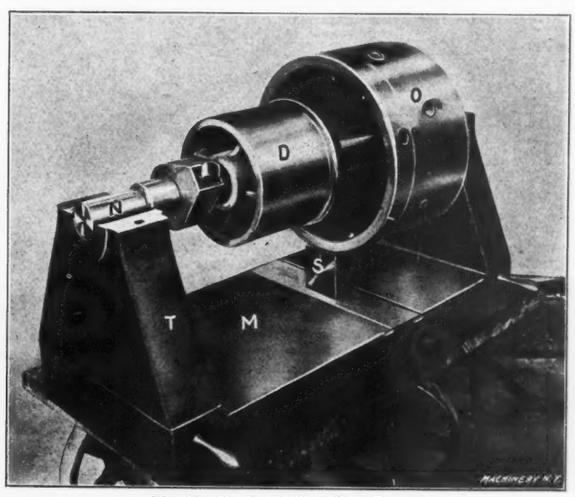


Fig. 11. Jig for Drilling Cam Drums

Jig for Drilling Forming Cams and Cam Drums

In Fig. 11 is shown a jig which is used for drilling the holes in the cam drum used on the Gridley multiple-spindle

automatic machines. In Fig. 13 the jig is shown in detail. When the drums *D* are being drilled, they are held on arbor *N*, which latter rests in bearings in frame *M*. After the drum has been placed on the arbor, as shown in Fig. 11, it is pushed inside of the sleeve *O*, which holds the guide bushings for the drill. The drums are located in the correct position inside of the drill bushing sleeve by means of the pin *P*, Fig. 13. The distance in the longitudinal direction is governed by the stop collar *R*. At *S* is shown a support which carries the weight of the arbor and sleeve when the removable support *T* is taken off to permit the removal of the drum that has been drilled and the mounting of a new drum on the arbor. As will be noted from the halftone illustration, the arbor *N* and sleeve *O* are rotated for bringing the bushings in line when drilling the successive holes. This arrangement of the jig

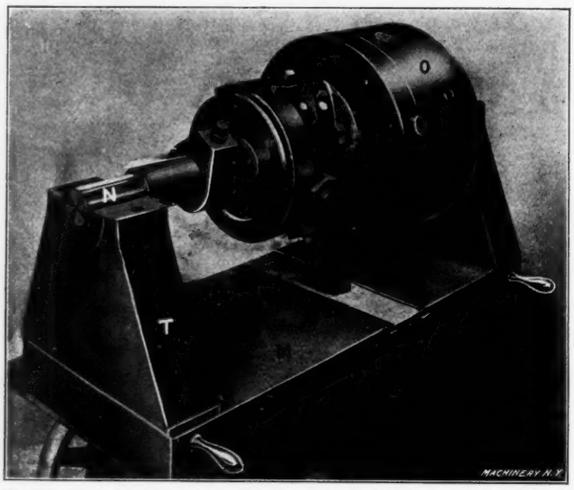


Fig. 12. Jig in Fig. 11 used for Drilling Forming, Return and Cut-off Cams

makes it very convenient to handle when in operation. It insures also absolute interchangeability as regards all the drums.

In Fig. 12 the same jig is shown, used in this case, however, for drilling the forming, cut-off and return cams used on the multiple spindle automatic machines built by the company. In this case a master drum is used, onto which the various cams are clamped in their proper positions as determined by stop plugs. The master drum is then pushed into the drill bushing sleeve, and the cams drilled the same as the drum. As the master drum is mounted on the arbor *N* the same as the cam drums, and as the cams are drilled from the same jig bushings in the sleeve *O* as is the drum, perfect duplication of the location of the holes drilled is insured. In Fig. 14 is shown a detail of the master drum indicated in Fig. 12. The cams to be drilled are located on the master drum by the removable collars *B* and *G* and the pins *A*, *F*, *K*, *L* and *M*. The clamps *C*, *E*, *H*, *I* and *J* hold the cams in place during the drilling operation. As will be noted in Fig. 12 the frame *M* and the arbor *N* are made long enough so that the master drum can slide out of the sleeve *O* after

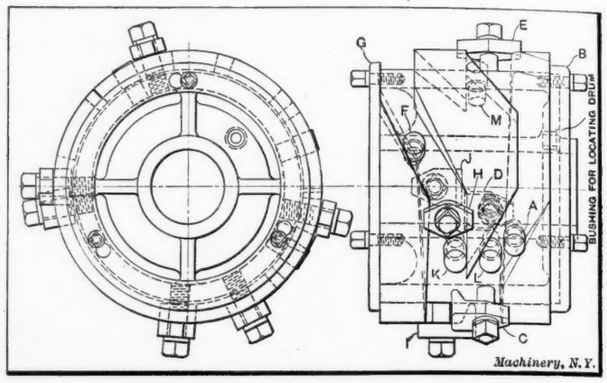


Fig. 14. Master Cam Drum shown in Place on Arbor in Fig. 12

the cams have been drilled and removed from the master drum, without removing the support *T*. Hence it is only in the case of drilling the cam drums that this support has to be removed. One of the advantageous features of this device, in addition to the accuracy that it makes possible, is that it saves the operator from lifting or turning over a heavy jig and for this reason saves time in its operation.— E. O.

* * *

It is reported that a new method for electroplating aluminum has recently been patented by Carl Rümpler of Schöneberg, near Berlin, Germany. A film of brass containing not less than 50 per cent copper and a small quantity of zinc (the less zinc the deposit contains the more tenaciously it will adhere) is deposited on the aluminum. In order to obtain the desired deposit, a small quantity of a haloid such as potassium chloride, bromide or iodide is used in the bath. The solution used is as follows:

Water	1 gallon
Double potassium and copper cyanide	5 ounces
Double potassium and zinc cyanide	2 ounces
Sodium sulphite	5 ounces
Caustic potash	2 ounces
Potassium chloride	1 ounce

Brass anodes are used and about 1.8 volt with a current density of from 2 to 3.6 amperes per square decimeter. The time required to deposit the film is from one to two minutes. After this operation the current should be shut off, and the aluminum transferred to the plating solution.

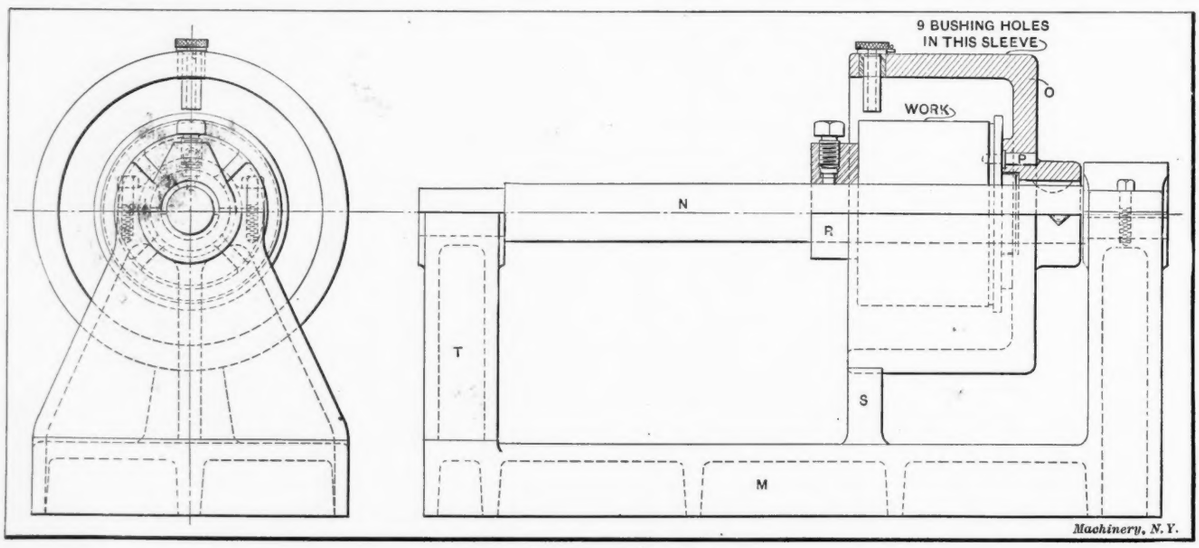


Fig. 13. Details of Jig in Fig. 11

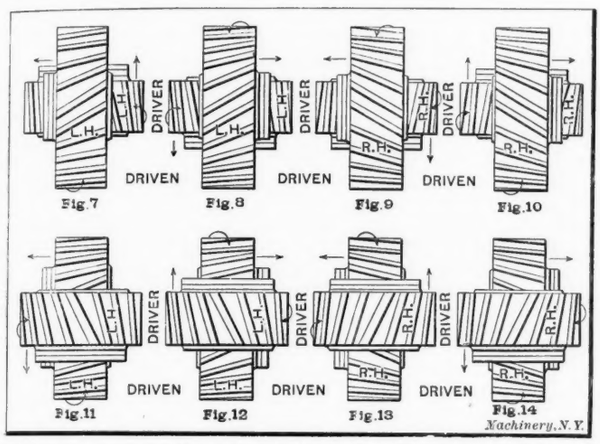
SPIRAL GEAR DESIGN—2*

By JAMES H. CARVER†

In the first installment of this article four cases dealing with spiral gears with the shafts parallel were referred to. In the present installment four cases of spiral gearing with the shafts at right angles will be dealt with. These cases, numbered consecutively with the cases stated in the previous installment, are as follows:

5. Shafts at right angles, ratio equal, and center distance approximate.
6. Shafts at right angles, ratio equal, and center distance exact.
7. Shafts at right angles, ratio unequal, and center distance approximate.
8. Shafts at right angles, ratio unequal, and center distance exact.

In the accompanying Data Sheet Supplement the procedure



Figs. 7 to 11. Thrust Diagrams for Spiral Gears with Shafts at Right Angles

to follow in calculating the required dimensions for these four cases is outlined, the data sheets being arranged in the same manner as those in the September number of MACHINERY.

The accompanying illustration gives a diagram for gears with shafts at right angles, the purpose of this diagram being the same as of that shown in the former installment of this article. The explanation given in connection with the former diagram should be referred to.

5. Shafts at Right Angles, Ratio Equal, and Center Distance Approximate

The sum of the spiral angles of both gears must in this, and in all the following cases, equal 90 degrees, and the direction of the spiral must be the same for both gears. When the spiral angles of both gears equal 45 degrees, the pitch diameters of both gears will be equal, and are found by the formula (see Data Sheet Supplement for notation):

$$D = \frac{N}{P_n \cos 45^\circ} = \frac{N}{0.70711\, P_n}$$

The other formulas are the same as those given in the previous installment.

6. Shafts at Right Angles, Ratio Equal, and Center Distance Exact

After deciding upon an approximate spiral angle of one gear, the number of teeth in each gear is found nearest the value $C P_n \cos \phi$ where ϕ is this approximate spiral angle, and C the exact center distance. If $\frac{N}{P_n \cos a} = C$, or $N = C P_n \cos a$, then N would be an approximate number of teeth with an exact spiral angle, but by making $a = \phi$, an approximate angle, then $N = C P_n \cos \phi$, or an exact number of teeth, after which, as shown in the following, an exact angle a can be found, for

$$\frac{N}{P_n \cos a} + \frac{N}{P_n \cos \beta} = 2C$$

where a is the exact spiral angle of one gear, and β the exact spiral angle of the other, but $\beta = 90^\circ - a$, or $\cos \beta = \sin a$. Then

$$\frac{N}{P_n \cos a} + \frac{N}{P_n \sin a} = 2C,$$

or

$$\frac{1}{\cos a} + \frac{1}{\sin a} = \frac{2CP_n}{N}$$

Multiplying by $\sin a \cos a$, gives:

$$\sin a + \cos a = \frac{2CP_n}{N} \sin a \cos a$$

Squaring,

$$\sin^2 a + 2 \sin a \cos a + \cos^2 a = \frac{4C^2P^2_n}{N^2} \sin^2 a \cos^2 a.$$

But,

$$2 \sin a \cos a = \sin 2a, \text{ and } \sin^2 a + \cos^2 a = 1.$$

Further,

$$\sin^2 a \cos^2 a = \tfrac{1}{4} \sin^2 2a.$$

Then,

$$1 + \sin 2a = \frac{C^2 P_n^2}{N^2} \sin^2 2a,$$

or

$$\sin^2 2a - \frac{N^2}{C^2 P_n^2} \sin 2a = \frac{N^2}{C^2 P^2_n}$$

Solving this equation we get

$$\sin 2a = \frac{N^2}{2\, C^2\, P^2_n} \pm \sqrt{\frac{N^2}{C^2\, P^2_n} + \left(\frac{N^2}{2\, C^2\, P^2_n}\right)^2}$$

which is the equation for finding twice the required angle.

7. Shafts at Right Angles, Ratio Unequal, and Center Distance Approximate

Here the only two terms which may not be decided upon at the outset are the number of teeth in each gear. Each, of course, must be a whole number and correspond with the center distance, angle of spiral, and normal pitch. Let

$$\frac{N}{P_n \cos a} + \frac{n}{P_n \cos \beta} = 2\, C,$$

and

$$\frac{N}{n} = R, \text{ or } N = R\, n.$$

Then

$$\frac{Rn}{P_n \cos a} + \frac{n}{P_n \cos \beta} = 2\, C.$$

Multiply by $P_n \cos a \cos \beta$. Then,

$$R\, n \cos \beta + n \cos a = 2\, C\, P_n \cos a \cos \beta$$
$$n\ (R \cos \beta + \cos a) = 2\, C\, P_n \cos a \cos \beta,$$

and

$$n = \frac{2\, C\, P_n \cos a \cos \beta}{R \cos \beta + \cos a}$$

which gives the number of teeth in the pinion in terms of the center distance, angle of spiral, and normal diametral pitch.

When a spiral angle of 45 degrees is used, the last formula becomes, by substituting the numerical values of the cosine of both angles, which is 0.70711;

$$n = \frac{2\, C\, P_n \ 0.70711 \times 0.70711}{R \times 0.70711 + 0.70711}$$

or

$$n = \frac{1.41\, C\, P_n}{R + 1}$$

8. Shafts at Right Angles, Ratio Unequal, and Center Distance Exact

This case is met with when two spiral gears are to replace two bevel gears, or when the conditions of the design demand an exact center distance and unequal ratio. The normal pitch, the ratio of number of teeth in large to small gear, the exact center distance, and the approximate spiral angle a of the large gear are all given or assumed. Then the number of teeth in the small gear is found from the formula:

$$n = \frac{2\, C\, P_n \sin a}{R \tan a + 1}$$

which is found as follows:

Let

$$\frac{N}{P_n \cos a} + \frac{n}{P_n \cos \beta} = 2\, C,$$

* With Data Sheet Supplement.

† Address: 761 Eastern Ave., Schenectady, N. Y.

or twice the center distance, or

$$\frac{N}{P_n \cos a} + \frac{n}{P_n \sin a} = 2\,C.$$

Let

$$\frac{N}{n} = R, \text{ or } N = R\,n,$$

Then

$$\frac{R\,n}{P_n \cos a} + \frac{n}{P_n \sin a} = 2\,C.$$

Multiply by $P_n \sin a \cos a$. Then,

$$Rn \sin a + n \cos a = 2\,C\,P_n \sin a \cos a,$$
$$n\,(R \sin a + \cos a) = 2\,C\,P_n \sin a \cos a,$$

or

$$n = \frac{2\,C\,P_n \sin a \cos a}{R \sin a + \cos a}$$

Divide by $\cos a$. Then,

$$n = \frac{2\,C\,P_n \sin a}{R \tan a + 1}$$

The formula $R \sec a + \text{cosec}\, a = \frac{2\,C\,P_n}{n}$, which is used in finding the exact spiral angle is found in the same manner as in some of the preceding cases. Let,

$$\frac{N}{P_n \cos a} + \frac{n}{P_n \cos \beta} = 2\,C, \text{ and } \frac{N}{n} = R, \text{ or } N = Rn.$$

Then,

$$\frac{R\,n}{P_n \cos a} + \frac{n}{P_n \sin a} = 2\,C.$$

Multiplying by $\frac{P_n}{n}$, we have:

$$\frac{R}{\cos a} + \frac{1}{\sin a} = \frac{2\,C\,P_n}{n}$$

or

$$R \sec a + \text{cosec}\, a = \frac{2\,C\,P_n}{n}.$$

This exact spiral angle is found by trial, by substituting values found in a table of secants and cosecants in the equation, after the proper value of the last member in the equation has been found from known values. About 45-degree angles will probably be the most used, unless for some reason of design, the spiral angle of one gear must be greater than that of the other. In using trigonometric tables to find values to satisfy the equation given, use first tenths only for trial, then hundredths, and so on, as the required value is approached. This shortens the work considerably. In solving this last equation, a table of functions, giving values to minutes, is necessary, as the value of its right-hand member must be to thousandths of an inch.

* * *

MILLING SCREW MACHINE CAMS*

By LEWIS A. WHITE†

The method of milling cam lobes for the Brown & Sharpe screw machine cams by using the vertical milling attachment and the spiral geared universal head, was described in an article entitled "Milling Screw Machine Cams," in the January, 1911, number of MACHINERY, engineering edition. In this article a method for calculating the angle to which the index head and milling attachment are to be set, was also given. This angle is determined with reference to the lead of the cam lobe and the spiral lead for which the milling machine is geared, and the general rule for finding the angle is as follows:

The sine of the angle to which to set the index head and vertical milling attachment equals the lead of the cam lobe divided by the spiral lead.

From this rule the required angle can, of course, be found by carrying out the required calculations. In the article previously referred to a method was outlined by means of which a spiral lead could be so selected that the angle would be within five minutes of either a whole or a half degree, as this facilitates accurate setting. In the following, a method is given, by means of which, by adopting certain constant spiral leads, the angle to which to set the index head can be found without calculation when the lead of the cam lobe is known. As the calculation is eliminated, there are no chances of mistakes, and while the results obtained are approximate only, they are close enough for all practical purposes. The method is as follows: When constant spiral leads, as given in the accompanying table, are used, multiply the cam lead by 10, and the product equals the angle to which to set the index head in degrees and decimals of a degree. (To multiply the cam lead by 10, simply move the decimal point one figure to the right.)

TABLE OF CONSTANT SPIRAL LEADS

Spiral Lead	Cam Lead	Greatest Error in Setting
5.76	From 0.00 to 1.40	4 minutes
5.818	From 1.41 to 2.00	6 minutes

The spiral lead of 5.76 can be used for most cross-slide and many lead cam lobes.

Example: Find the angle to which to set the index head when the lead of the cam lobe is 0.725 inch?

From the table given we find that the lead of spiral to be used in this case is 5.76, and from the rule given the angle is found to be 7.25 degrees, or 7 degrees 15 minutes. As the

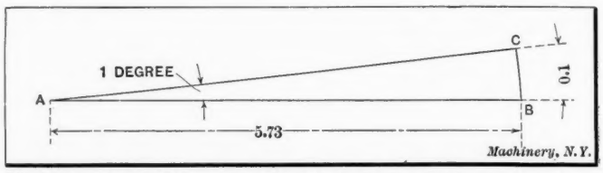


Illustration of Principle on which Method for Finding Setting Angle is based

theoretically correct setting angle is 7 degrees 14 minutes, the approximation, it will be seen, is closer than the accuracy it is possible to obtain in setting the index head to its graduations. The index head cannot be set very much closer than to one-third or one-quarter degree. This accuracy can be obtained, however, if care is taken.

[The readers of MACHINERY will be interested in the method by means of which the constant spiral leads are obtained. Assume that in the accompanying illustration line *BC* represents the lead of the screw machine cam, and that this lead is 0.1 inch. Assume further that the setting angle *BAC* is found by the rule given by the author. This angle is then 1 degree. The corresponding spiral lead is $\frac{0.1}{\sin 1 \text{ deg.}} = \frac{0.1}{0.01745}$ = 5.73. If the sines of angles were proportional to the angles as expressed in degrees and minutes, we could now adopt 5.73 as a constant spiral lead, and find the setting angles by multiplying the cam lead by 10, as explained. The sines of angles, are, however, not directly proportional to the angles, but increase at a rate somewhat less than that of the angles. Hence, in order to obtain a closer approximation by the method outlined we do not adopt 5.73 for the constant spiral lead, but a slightly greater lead; hence 5.76 is adopted for the smaller cam leads and angles and 5.818 for the greater leads and angles. These values, of course, are determined by trial, the object being to introduce as small an error as possible. A still smaller error would be introduced by using the intermediate lead 5.788 for the intermediate cam leads, but as the greatest error now introduced does in no case exceed 6 minutes, this additional lead is not required. The advantage of using as few constant leads as possible is that the gearing may be left intact while cams with slightly different leads are being milled.—EDITOR.]

* * *

The small end of the taper plug gage is the basis for measurement of taper shanks. Hence if a shank is shorter than the standard, it will carry the number of the standard if its small end corresponds in diameter to that of the plug. For example, a screw slotting bushing 0.450 inch diameter at the small end, 1 inch long, having a taper of ½ inch to the foot, is the B. & S. No. 5 taper, and so on.

* See MACHINERY, engineering edition, January, 1911: "Milling Screw Machine Cams."

† Address: 478 Sixth St., Brooklyn, N. Y.

MAKING THE RONEO PENCIL SHARPENER

The pencil sharpener shown assembled to the right in Fig. 1 is a small device that has been put on the market by the Roneo Co., 371 Broadway, New York City. This pencil sharpener is made for the Roneo Co. by the Sloan & Chace Mfg. Co., Newark, N. J., manufacturer of special machinery, tools and dies. The machining operations are mostly of the straight-work variety, the manufacturing operations deriving their chief interest from the product. However, there are some tools of interest employed which are worth while recording.

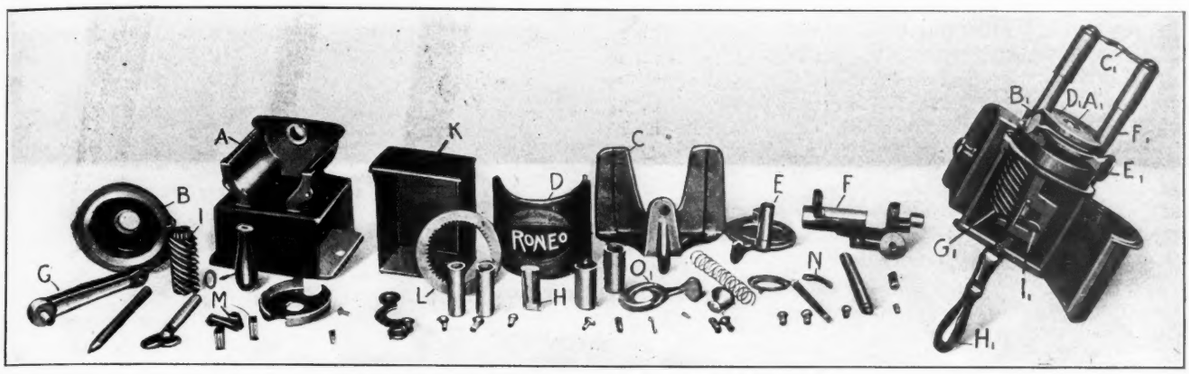


Fig. 1. The Roneo Pencil Sharpener before and after Assembling

Method of Operating the Roneo Pencil Sharpener

In operation, the pencil is placed in the jaws A_1, which are opened by depressing the thumb-lever B_1, the pencil being forced in against the helical cutter G_1, and resting in the groove in the plate C_1. The feed-body D_1 is then drawn back by pressing and pulling on the thumb-lever E_1. As this feed-body is acted upon by a spiral spring held in the hollow sleeve F_1, the pencil is automatically fed to the helical cutter G_1. All that is necessary now is to turn the handle H_1 to the right. A fine or blunt point can be obtained by moving the thumb-stop I_1 in the required direction.

Manufacturing Operations

The main casting shown at *A* is made from cast iron, milled, drilled and then japanned. As the machining operations on this main casting are of a very simple character, they need not be described. The same remarks apply to the front cover shown at *B*. This casting, while being machined in the lathe, is held in a chuck provided with suitable jaws, and the casting is faced, the hole bored and reamed, and the shoulder or boss around the hole faced. After this, the casting is placed in a drill jig and the screw holes are drilled and tapped. Previous to the machining operations, the casting is japanned. The table clamp *C* is also a plain casting and passes through the japanning, drilling and tapping operations. The top cover shown at *D* is first japanned, then drilled and the name put on by the ordinary transfer method.

The feed-body shown at *E* is a plain casting which is japanned, then machined in the lathe and counterbored, after which the holes are drilled and tapped in a simple jig. The cutter holder *F* is made from cast iron and is japanned, then drilled and reamed, after which it is placed in a milling machine and milled to length. It is then placed in a pair of jaws held in an ordinary chuck in the lathe, when one end is turned; then the casting is reversed and the other end turned, drilled and tapped. The cast-iron crank lever *G* requires only one hole to be drilled in each boss; these holes are then tapped and the screw is placed in the boss in one end on which the wooden handle *O* is fitted. The pencil controller *H* is a die-casting, and requires no machining operations except facing and tapping a hole in one end.

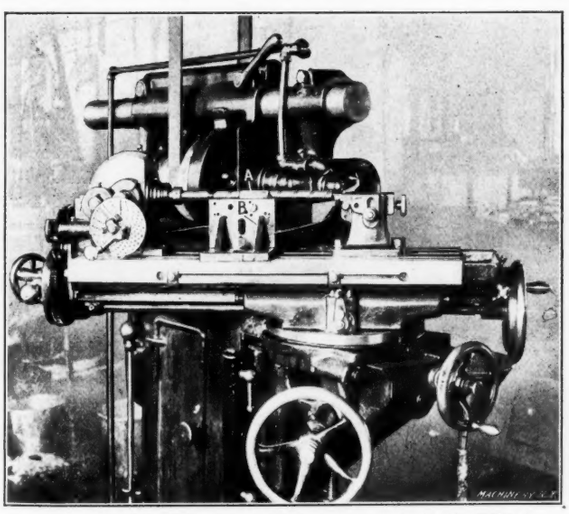


Fig. 2. Cutting the Teeth in the Bar from which the Six Helical Cutters are made

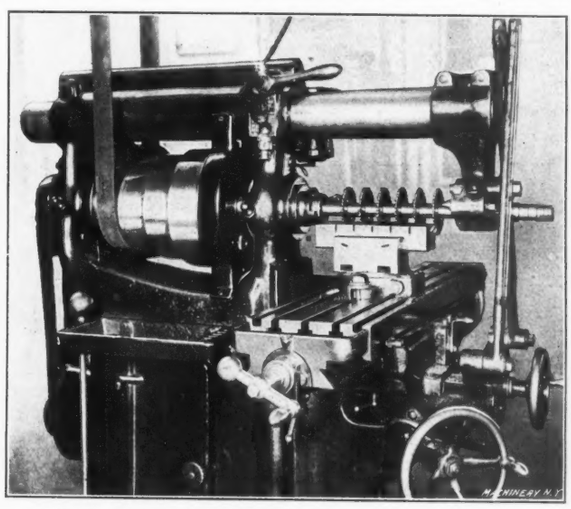


Fig. 3. Cutting the Helically-cut Bar into Lengths sufficient for Six Cutters

Making the Helical Cutter

Making the helical cutter, is possibly the most interesting operation on this pencil sharpener, and in fact this is the most important part. This helical cutter is shown at *I* with the pinion assembled. The first operation on this cutter is to turn up a bar from which six cutters are made. This bar is then notched on the end which is used for driving when forming the teeth. The rod is then placed in the milling machine, as shown in Fig. 2, where the grooves forming the teeth are cut, the rod resting on a block *A*, which is attached to an angle-plate *B*. The machine is set to cut a spiral giving a helix angle of 45 degrees; eight teeth are cut in the cutter.

After cutting these grooves in the rod, it is taken to the milling machine shown in Fig. 3, where it is cut up into the desired lengths. The device for holding the bar while cutting is a simple fixture, consisting of vise jaws provided with V-grooves in which the bar is held, and six circular saws are used to cut up the bars to the required lengths. The next operation is to bore and tap the hole in the cutter for the reception of the pinion. This operation is accomplished in a

hand screw machine, and as it is of a simple character needs no description. After the drilling and tapping operation, the cutter is then ready for hardening, and after hardening the pinion is assembled in it.

The teeth in this cutter are under-cut so that a knife-edge will be formed, which is conducive to free and clean cutting. The cutter is also ground, and a special machine has been rigged up for performing this operation. This machine is shown in Fig. 4. The cutter is mounted on the centers, and is guided by a pin *A* which fits in the grooves of the cutter. This pin rotates the cutter as the carriage travels back and forth. The pin *A* is carried past the end of the cutter, so that the latter can be indexed for each succeeding tooth. The indexing is accomplished by a link *B* which imparts an oscillating motion to the disk *C*. This disk *C*, in turn, moves a finger *D* which indexes the cutter for each tooth. The finger *D* operates the disk against the tension of the spring *E*. The indexing of this machine is entirely automatic.

Tools for the Dust Pan and Internal Gear

The next part of interest is the dust pan, which is shown at *K* in Fig. 1. This pan is first blanked with the sub-press

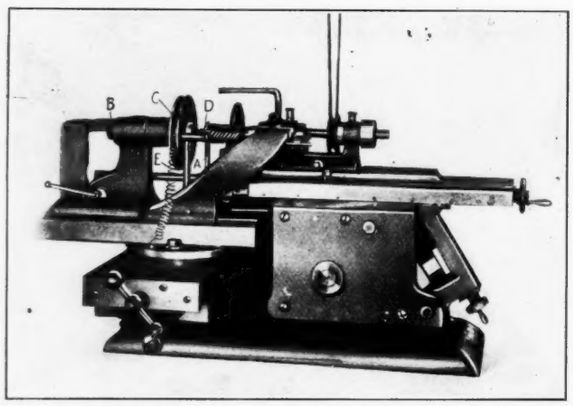


Fig. 4. Grinding the Teeth of the Helical Cutter in a Semi-automatic Machine

punch and die* shown in Fig. 5, where the blank is also shown. The hole in which the knob is held is also punched in this operation.

The next operation is the drawing up of the box, which is accomplished in the punch and die shown to the right in Fig. 6. The blank is located in the correct position by the guides *A*, and as the punch *B* descends, it forces the blank down into the die, thus drawing up the sides of the box. As will be noticed this box is drawn with square corners, which is easily accomplished by this method of manufacture. The die-stripper

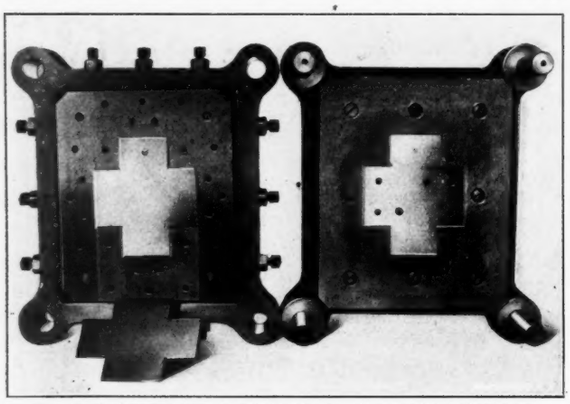


Fig. 5. Sub-press Punch and Die for Blanking out the Dust Pan

C, of course, is actuated by springs held in the die-bolster. A completed dust pan is shown at *D* standing on top of the punch.

Another interesting sub-press punch and die, shown to the left in Fig. 6, blanks out the internal gear shown at *L* in Fig. 1. The teeth are formed in the same operation. This die is of the ordinary sub-press construction, but, as the reader will see, it is a fine piece of tool work. Two blanks are shown at *E*, beside the punch and die. *F* is the punch-holder and *G* the die-holder.

Referring to Fig. 1, three pencil jaws shown at *M* are blanked out in a punch and die of sub-press construction, then casehardened and nickel-plated, after which the three blanks are

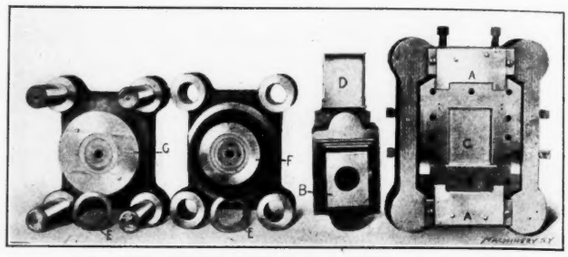


Fig. 6. Sub-press Punches and Dies for Forming the Dust Pan and Blanking the Internal Gear

riveted together, thus making one jaw. Three of these completed jaws (nine blanks in all) are required in each pencil sharpener. The point adjustment lever, which is shown at *N* Fig. 1, is blanked and pierced in one operation, and then bent in a simple bending die. This point adjustment lever is so made that by moving it in one direction the point of the pencil passes over the top of the lever, while if moved in the other direction the point comes against the lever. This provides for making a sharp or blunt point on the pencil as desired.

The jaw adjuster shown at *O* is blanked out in the punch press, after which it is placed in another die where the eccentric slots are cut. Small pins driven into the jaws fit into these eccentric slots, and in this way the jaws are adjusted to hold various sizes and shapes of pencils. The range of the jaws is from 3/16 to 7/16 inch. After the eccentric slots are cut out, the handle is bent in a simple bending die. All the

Fig. 7. View of the Assembling Room

other parts shown in Fig. 1 are produced by simple operations —in punch presses and screw machines—and need no description.

This simple little device requires a large number of machining operations, and has a greater number of parts than would at first be thought necessary. However, each part has its own peculiar function to perform, and adds to the efficient operation of the pencil sharpener. The final assembling of the parts is practically all done by hand, some of the parts being assembled during the process of manufacture. A general view of the assembling room is shown in Fig. 7. About 200 of these pencil sharpeners are turned out per day by the Sloan & Chace Mfg. Co.

D. T. H.

* * *

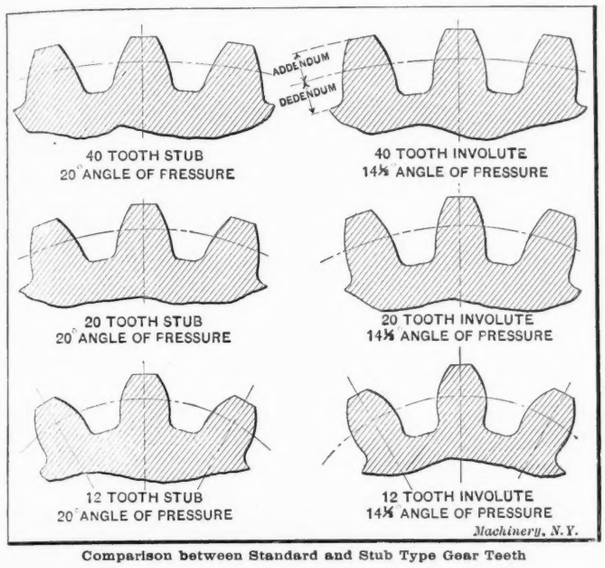
The dust produced in grinding brass castings is a valuable consideration and should be caught and saved because of its intrinsic value—also to preserve the health and comfort of the operatives. One of the makers of disk grinders provides a simple exhaust hood which gathers all the dust and deposits it into a barrel. This dust more than paid for the operator's time in finishing brass scale beams from the sides of which about 1/32 inch was removed.

*For a detailed description of sub-press die construction, see "Sub-Press Work at the Sloan & Chace Shops," December, 1906, engineering edition, and MACHINERY'S Reference Series Book, No. 26, "Modern Punch and Die Construction."

THE STUB GEAR-TOOTH*

By V. BROCKBANK†

Ever since the stub gear-tooth began to be advocated a few years ago, the demand for gears with this type of tooth has steadily increased. Its application has been particularly successful in the case of automobiles, as increased efficiency



Comparison between Standard and Stub Type Gear Teeth

and excellent results in all respects have been obtained. A comparison with the usual form of gear tooth will be of interest. We have on the one hand the ordinary involute tooth of 14½-degree angle of pressure, with an addendum of

DIAMETRAL PITCH GEAR TOOTH PARTS FOR STUB TEETH

Diametral Pitch	Equivalent Circular Pitch	Thickness of Tooth on Pitch Line	Addendum	Working Depth	Depth of Space below Pitch Line	Whole Depth
½	6.2382	3.1416	1.5708	3.1416	1.8849	3.4557
¾	4.1888	2.0944	1.0472	2.0944	1.2566	2.3038
1	3.1416	1.5708	0.7854	1.5708	0.9424	1.7278
1¼	2.5133	1.2566	0.6283	1.2566	0.7539	1.3822
1½	2.0944	1.0472	0.5236	1.0472	0.6283	1.1519
1¾	1.7952	0.8976	0.4488	0.8976	0.5385	0.9873
2	1.5708	0.7854	0.3927	0.7854	0.4712	0.8639
2¼	1.3963	0.6981	0.3490	0.6981	0.4188	0.7678
2½	1.2566	0.6283	0.3141	0.6283	0.3769	0.6910
2¾	1.1424	0.5712	0.2856	0.5712	0.3427	0.6283
3	1.0472	0.5236	0.2618	0.5236	0.3141	0.5759
3½	0.8976	0.4488	0.2244	0.4488	0.2692	0.4936
4	0.7854	0.3927	0.1963	0.3927	0.2355	0.4318
5	0.6283	0.3141	0.1570	0.3142	0.1884	0.3454
6	0.5236	0.2618	0.1309	0.2618	0.1571	0.2880
7	0.4488	0.2244	0.1122	0.2244	0.1346	0.2468
8	0.3927	0.1963	0.0981	0.1963	0.1177	0.2158
9	0.3491	0.1745	0.0872	0.1745	0.1046	0.1918
10	0.3142	0.1571	0.0785	0.1571	0.0942	0.1727
11	0.2856	0.1428	0.0714	0.1428	0.0857	0.1571
12	0.2618	0.1309	0.0654	0.1309	0.0785	0.1439
13	0.2417	0.1208	0.0604	0.1208	0.0725	0.1329
14	0.2244	0.1122	0.0561	0.1122	0.0673	0.1234
15	0.2094	0.1047	0.0523	0.1047	0.0627	0.1150
16	0.1963	0.0982	0.0491	0.0982	0.0589	0.1080
17	0.1848	0.0924	0.0462	0.0924	0.0554	0.1016
18	0.1745	0.0873	0.0436	0.0873	0.0523	0.0959
19	0.1653	0.0827	0.0413	0.0827	0.0495	0.0908
20	0.1571	0.0785	0.0392	0.0785	0.0470	0.0862
22	0.1428	0.0714	0.0357	0.0714	0.0423	0.0785
24	0.1309	0.0654	0.0327	0.0654	0.0392	0.0719
26	0.1208	0.0604	0.0302	0.0604	0.0362	0.0664
28	0.1122	0.0561	0.0280	0.0561	0.0336	0.0616
30	0.1047	0.0524	0.0262	0.0524	0.0313	0.0575
32	0.0982	0.0491	0.0245	0.0491	0.0294	0.0539
34	0.0924	0.0462	0.0231	0.0462	0.0277	0.0508
36	0.0873	0.0436	0.0218	0.0436	0.0261	0.0479

0.3183 times the circular pitch and a dedendum of 0.3683 times the circular pitch. In the stub gear-tooth, on the other hand, we have an angle of pressure of 20 degrees, with an addendum of 0.250 and a dedendum of 0.300 times the circular pitch.

The first proportions of stub gear-teeth, which are still used to a fairly large extent, were not according to the dimensions just given, but were based on the use of two diametral pitches; one diametral pitch, say 8, was used to obtain the addendum and dedendum, while another diametral pitch, say 6, was used to obtain the thickness of the tooth, and the number of teeth, etc. The chief disadvantages of this system are that the depth of the tooth is not a direct function of the circular pitch, and that this system can be used only in combination with diametral pitch gears. When the stub gear-tooth is made according to the proportions given in the first paragraph of this article, the system can be applied to either diametral, circular, or millimeter pitch gears. In the accompanying illustration it will be seen that the strength of the stub gear-tooth is considerably greater than the strength

CIRCULAR PITCH GEAR TOOTH PARTS FOR STUB TEETH

Circular Pitch	Circular Pitch (Decimal Equivalent)	Diametral Pitch	Thickness of Tooth on Pitch Line	Addendum	Working Depth	Depth of Space below Pitch Line	Whole Depth
2	2.0000	1.5708	1.0000	0.5000	1.0000	0.6000	1.1000
1 7/8	1.8750	1.6755	0.9375	0.4687	0.9375	0.5624	1.0311
1 3/4	1.7500	1.7952	0.8750	0.4375	0.8750	0.5250	0.9625
1 5/8	1.6250	1.9333	0.8125	0.4062	0.8125	0.4874	0.8936
1 1/2	1.5000	2.0944	0.7500	0.3750	0.7500	0.4500	0.8250
1 7/16	1.4375	2.1855	0.7187	0.3593	0.7187	0.4311	0.7904
1 3/8	1.3750	2.2848	0.6875	0.3437	0.6875	0.4124	0.7561
1 1/3	1.3333	2.3562	0.6666	0.3333	0.6666	0.3999	0.7332
1 5/16	1.3125	2.3936	0.6562	0.3281	0.6562	0.3937	0.7218
1 1/4	1.2500	2.5133	0.6250	0.3125	0.6250	0.3750	0.6875
1 3/16	1.1875	2.6456	0.5937	0.2968	0.5937	0.3561	0.6529
1 1/8	1.1250	2.7925	0.5625	0.2812	0.5625	0.3374	0.6186
1 1/16	1.0625	2.9568	0.5312	0.2656	0.5312	0.3187	0.5843
1	1.0000	3.1416	0.5000	0.2500	0.5000	0.3000	0.5500
15/16	0.9375	3.3510	0.4687	0.2343	0.4687	0.2811	0.5154
7/8	0.8750	3.5904	0.4375	0.2187	0.4375	0.2624	0.4811
13/16	0.8125	3.8666	0.4062	0.2031	0.4062	0.2437	0.4468
3/4	0.7500	4.1888	0.3750	0.1875	0.3750	0.2250	0.4125
11/16	0.6875	4.5696	0.3437	0.1718	0.3437	0.2061	0.3779
5/8	0.6666	4.7124	0.3333	0.1666	0.3333	0.1999	0.3666
9/16	0.6250	5.0265	0.3125	0.1562	0.3125	0.1874	0.3436
1/2	0.5625	5.5851	0.2812	0.1400	0.2812	0.1687	0.3093
7/16	0.5000	6.2832	0.2500	0.1250	0.2500	0.1500	0.2750
3/8	0.4375	7.1808	0.2187	0.1093	0.2187	0.1311	0.2404
5/16	0.3750	8.3776	0.1875	0.0937	0.1875	0.1124	0.2061
1/3	0.3333	9.4248	0.1666	0.0833	0.1666	0.0999	0.1832
5/16	0.3125	10.0531	0.1562	0.0781	0.1562	0.0937	0.1718
1/4	0.2500	12.5664	0.1250	0.0625	0.1250	0.0750	0.1375
1/5	0.2000	15.7080	0.1000	0.0500	0.1000	0.0600	0.1100
3/16	0.1875	16.7552	0.0937	0.0468	0.0937	0.0561	0.1029
1/6	0.1666	18.8496	0.0833	0.0416	0.0833	0.0499	0.0915
1/8	0.1250	25.1327	0.0625	0.0312	0.0625	0.0374	0.0686
1/9	0.1111	28.2743	0.0555	0.0277	0.0555	0.0332	0.0609
1/10	0.1000	31.4159	0.0500	0.0250	0.0500	0.0300	0.0550
1/16	0.0625	50.2655	0.0312	0.0156	0.0312	0.0187	0.0343
1/20	0.0500	62.8318	0.0250	0.0125	0.0250	0.0150	0.0275

of the corresponding standard gear tooth, the increase in strength amounting in some cases, for a small number of teeth, to nearly one hundred per cent. It has been said that the increased angle of pressure of the stub gear-tooth system increases the pressure on the bearings, but this increase is very slight, theoretically, and may be ignored in practice. The sliding contact of the teeth diminishes as the pressure increases.

The advantages of the stub tooth may be stated as follows:

1. Greater strength.
2. Equal arc of rolling contact to the 14½-degree involute.
3. Extreme sliding contact avoided.
4. More even wearing contact.

As a disadvantage it may be mentioned that we require a greater number of rotary cutters to cover a given range of teeth. For the standard involute system eight cutters are required, whereas the stub-tooth system requires sixteen in order to produce good gears. When a generating machine, such as the Fellows gear shaper is used, only one cutter is required for each pitch, as the cutting action of this machine is that of a pinion meshing with a gear-wheel.

The tables accompanying this article give the dimensions

* See also MACHINERY, engineering edition, April, 1908: "The Stub-tooth Gear."

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of stub-tooth parts for diametral and circular pitches, and for modules given according to the metric system. These

MILLIMETER MODULE GEAR TOOTH PARTS FOR STUB TEETH

Millimeter Module	Circular Pitch in Inches	Thickness of Tooth on Pitch Line	Addendum in Inches	Working Depth	Depth of Space below Pitch Line	Whole Depth of Tooth
1	0.1236	0.0618	0.0309	0.0618	0.0371	0.0680
1¼	0.1546	0.0773	0.0386	0.0773	0.0463	0.0849
1½	0.1855	0.0927	0.0463	0.0927	0.0555	0.1018
1¾	0.2164	0.1082	0.0541	0.1082	0.0649	0.1190
2	0.2473	0.1236	0.0618	0.1236	0.0741	0.1359
2¼	0.2783	0.1391	0.0695	0.1391	0.0834	0.1529
2½	0.3092	0.1546	0.0773	0.1546	0.0927	0.1700
2¾	0.3401	0.1700	0.0850	0.1700	0.1020	0.1870
3	0.3710	0.1855	0.0927	0.1855	0.1112	0.2039
3½	0.4329	0.2164	0.1082	0.2164	0.1298	0.2380
4	0.4947	0.2473	0.1236	0.2473	0.1483	0.2719
4½	0.5566	0.2783	0.1391	0.2783	0.1669	0.3060
5	0.6184	0.3092	0.1546	0.3092	0.1855	0.3401
5½	0.6802	0.3401	0.1700	0.3401	0.2040	0.3740
6	0.7421	0.3710	0.1855	0.3710	0.2226	0.4081
7	0.8658	0.4329	0.2164	0.4329	0.2597	0.4761
8	0.9895	0.4947	0.2473	0.4947	0.2967	0.5440
9	1.1131	0.5565	0.2782	0.5565	0.3338	0.6120
10	1.2368	0.6184	0.3092	0.6184	0.3710	0.6802
11	1.3605	0.6802	0.3401	0.6802	0.4081	0.7482
12	1.4842	0.7421	0.3710	0.7421	0.4452	0.8162
14	1.7316	0.8658	0.4329	0.8658	0.5194	0.9523
16	1.9789	0.9894	0.4947	0.9894	0.5936	1.0883

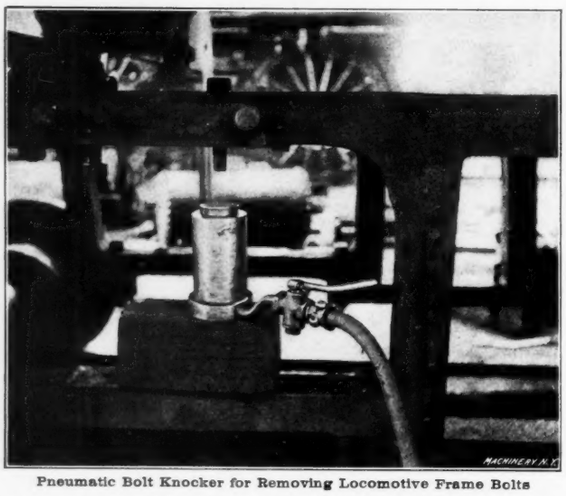
tables are based on an addendum of 0.250 and a dedendum of 0.300 times the circular pitch, as stated above.

* * *

PNEUMATIC BOLT KNOCKER

Driving out locomotive frame bolts is one of the jobs in a railway shop that sometimes causes trouble, as occasionally a bolt cannot be budged by ordinary means and it is necessary to resort to drilling. Small cannon are used in some shops for shooting out tight bolts, and while this method is very successful, it is also rather dangerous, as the cannon frequently does more than is necessary: It knocks out the bolt and sends it up through the shop roof for good measure.

A very effective and safe device for removing frame bolts is shown in the illustration. This is a pneumatically operated



Pneumatic Bolt Knocker for Removing Locomotive Frame Bolts

"bolt knocker," consisting simply of a cylinder and plunger. Connection is made with the pneumatic hammer "air line" and the movements of the plunger are controlled by the valve shown, the valve being opened to admit air beneath the plunger for each stroke. The plunger in its "down" position should be a little distance from the bolt, as the illustration shows, to obtain a good blow. The plunger of this particular knocker has a shoulder on its lower end that engages a corresponding shoulder in the cylinder when in its highest position. Were it not for this feature, the plunger might inadvertently be forced out with disastrous results; in fact, the lack of such a safety device on a tool of this kind resulted in the loss of at least one life. This type of knocker is used in the Chambersburg shops of the Cumberland Valley R. R.

THE PHOROGRAPH

By FREDERICK H. MOODY*

Mechanisms, in general, present but little difficulty in the analysis for the determination of the relative movements of the various members; anything, however, that tends to simplify such an analysis is generally welcomed by designers. A number of systems have been devised and tried out with more or less success, but the majority of them have been eventually dropped for the pure and simple drafting-board method.

The method of analysis to be here described has all the desired advantages; it is simple and may be rapidly applied. It was originated by Mr. T. R. Rosebrugh, professor of electrical engineering at the University of Toronto, and was called by him the "phorograph." So simple did it seem that it has been adopted for instructive purposes by the mechanical engineering department of that institution. It might incidentally be mentioned that Prof. Rosebrugh has invented several graphical systems of analysis, as applied to vectoral analysis of different conditions, one of which, in particular, might be noted; it is a system of thoroughly analyzing alternating-current circuits, considering the various phenomena due to phase relations, etc., for both motor and generator. This graphical solution of an otherwise complex subject is remarkably simple, and considers all phases of the subject in a manner quite as thoroughly as would an analytical solution, the graphical method having the added advantage of making the errors pos-

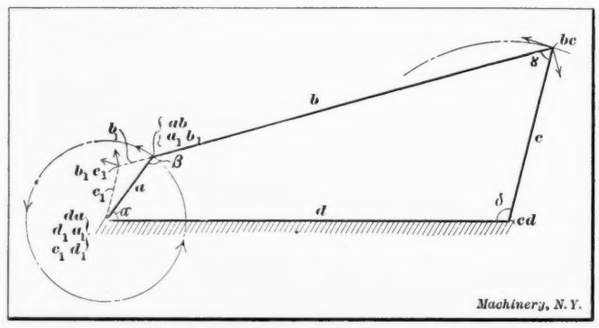


Fig. 1. Simple Four-link Mechanism to illustrate the Theory of the Phorograph

sible of ready detection, as well as rendering the problem capable of an easy solution by bringing the visual organs into play with the reasoning faculties.

To return to the subject: The system is based on the fact that in nearly all mechanisms there is at least one member revolving at a uniform speed, and to which the motion of all the other parts moving at variable speeds is referred. This is true in such common examples as the steam engine with its uniformly revolving crank; the shaper, with its constant-speed drive shaft; the slotter, with its constant-speed shaft; and many other similar mechanisms too numerous to mention.

As an example, consider the plain four-link mechanism, shown in Fig. 1, the links being a, b, c and d, of which a is revolving at a uniform speed and d is stationary, representing the frame. It is clear that links b and c are moving at speeds depending on their relative locations with regard to constant-speed link a. If, by some means, a point on the link a could be found that would have exactly the same speed as some point on the link c at a given instant, the velocity of that point on link c would be fully determined, since the speed of each of the many points on link a is known from its constant rotative motion. As a means of designating, call the joints of the links the combined letters of the adjacent links; thus, the joint between link a and b is ab.

If the link a be revolved in the direction indicated, up to a certain point the angle β will continue to decrease. This means that while the link a is revolved in a counter-clockwise manner with respect to stationary part d, the link b is revolved in a clockwise manner with respect to the moving link a. Thus, any point on link b produced, to the left of joint ab, is moving upward with respect to a, while points on b to the right are

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moving downward. Bear in mind, however, that every point in b, and b produced, has exactly the same direction of motion relative to the point of revolution ab, and every point in b to the right of ab has a point to the left of ab that has an exactly similar motion. This equivalent point, for lack of a better name, is called the "image" of the real point and is indicated by sub-letters; thus, the point bc in the link b has a counterpart or image b_1c_1 somewhere along the line b produced, to the left of ab. Due consideration must be given to the fact that link b will only revolve counter-clockwise until a and c are parallel, after which they move in the same rotary direction. This depends on whether or not b_1 c_1 and bc are on the same side of ab. For matters of explanation, this feature need not be dwelt upon.

Now consider the point bc as a point in the link c instead of in link b. As such, its motion is in a counter-clockwise di-

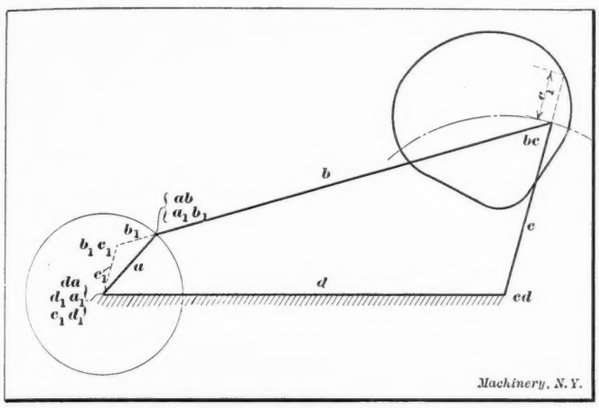

Fig. 2. Simple Four-link Mechanism showing the Application of the Phorograph

rection with regard to the center of rotation cd. Since the link d is stationary, any point on any link pivoted to d and parallel to c will have a motion in the same direction as any point in c. Hence, if through point da a line be drawn parallel to c, some point in it will have a motion about da exactly the same as the point bc about cd; but some point in b produced has a motion similar to point bc considered as a point in b. Therefore the point b_1c_1 where these two constructed lines intersect will be the image of the point bc. Hence, the point b_1c_1 has all its motions about da exactly the same as the original point bc about cd. It must be remembered, however, that these im-

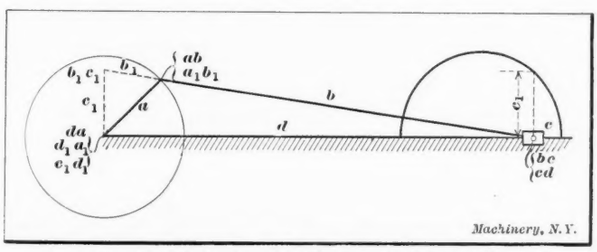

Fig. 3. Four-link Mechanism, One Member of which is sliding as in an Engine, analyzed by the Phorograph

ages are only instantaneous; that is, for every new position of each of the links the images change location.

The link c_1 will then be the image of the real link c. If the length of a be a measure of the velocity of the point ab to some scale, the length c_1 will represent the instantaneous velocity of the point bc to the same scale. There is thus provided a ready means of determining the velocity of any point in the mechanism by "imaging" it onto the constant-speed link a. (The link a is considered as a large member of sufficient size to include the images in all positions.)

The point da will, of course, be its own image, being already on a. Similarly the image of ab and the point ab are one and the same; the image of cd will be at the point da. The underlying idea is to find images on the uniformly revolving link a that have exactly the same characteristics as the real points on their respective members; these images revolving instantaneously at a uniform speed, can thus have their speeds determined.

Fig. 2 shows an application of the phorograph to a similar mechanism. After determining the images b_1 and c_1 of links b and c for a number of different locations of the crank a, these different lengths c_1 are plotted along c from the point bc as indicated; the inverted pear-shaped diagram indicates the velocities of the point bc at the different positions along its path of motion.

Coming to a four-link mechanism in which one of the members is sliding, as in the engine mechanism indicated in Fig. 3, the conditions are somewhat different, but still the phorograph principle holds good: a is the constant-speed crank; b, the connecting-rod; c, the sliding crosshead; and d, the stationary frame. The junctures of b and c at bc, and c and d at cd, are coincident points, though it is quite apparent that the motion between b and c is quite different to that between c and d. As a point in b, the image of bc will be at b_1c_1, somewhere along bc produced; also as b_1c_1 has a horizontal motion, it must be in a vertical line through da, as only such points in a have a horizontal motion. Thus the image will be at the point where the two lines intersect, as indicated at b_1c_1. This image b_1c_1 may be obtained for any position of a.

A shaper mechanism is outlined in skeleton in Fig. 4. Here, a very simple means of analyzing the exact movements of the ram is shown. a is the crank; b, the sliding crank-block; c, the shaper lever; d, the frame; and e, the ram. The images of cd and da will be at the latter point, at the center of rotation of the constant-speed link a. As it revolves, the block b slides up and down c. The image a_1b_1 of the point ab—the joint between a and b—is that joint itself, as there is no relative link movement between the two. As a point in link b, the point bc moves in a line parallel to link c; as a point in the link c, it moves at right angles to the link c, so that the juncture of these two lines, at b_1c_1, is the image of the point bc. Being a point on the uniformly moving link a, it has the same movement as the original point bc. The distance between b_1c_1 and c_1d_1 corresponds to the distance between bc and cd; so in order to obtain the full image of the link c, we must join cd and b_1c_1, producing this line to meet a tangent from the point ce. From this point of intersection, drop a perpendicular to cut a line through c_1d_1 and b_1c_1 produced, in the point c_1e_1. The line between the points c_1d_1 and c_1e_1 is the image c_1 of the link c, obtained by simple proportion, this method of obtaining it being simply a constructional means of so doing. Laying out this distance c_1 from the point ce, for various positions of a, gives the velocity diagram of the ram to the same scale, as the length a represents the velocity of the point ab.

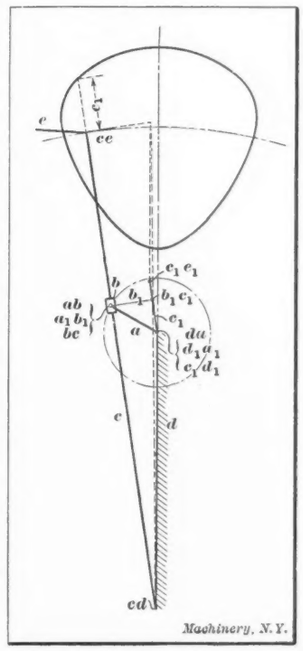

Fig. 4. Whitworth Quick-return Motion of a Shaper, analyzed by the Phorograph

Designers will find this phorograph of invaluable assistance in the analyzing of mechanisms. Although it may be difficult of comprehension at the first reading, a little practice will make its use quite simple.

* * *

It has been found difficult to make large steel gears out of steel castings on account of the difficulty of getting a perfectly sound casting. One machine tool builder in the Middle West, therefore, has abandoned the use of steel castings for large gears, and instead shrinks a forged steel ring onto a cast-iron gear body, much in the same way as tires are shrunk onto car wheel centers. Very satisfactory results are obtained in this way.

AUTOMATIC FEEDS FOR POWER PUNCHING PRESSES*

By HART PRESTON

Many articles formerly made of cast metals are now produced equally as strongly, and more cheaply, of stamped sheet metal through the adaptation of various automatic press-feeds. While the prime feature of all automatic feeds is the increased output which they effect, they also possess, in many cases, the valuable feature of reducing the number of operations, as well as the number of operators, required. Another important feature of automatic press-feeds is the safety which they insure to operators, as compared with the ordinary hand-fed presses. Various feeds are entirely automatic, the operator having only to keep the machines constantly supplied with the metal from which the punchings are made. However, on dial and other feeds which only automatically carry the work forward, under and away from the dies—especially on riveting, assembling, clinching and forming operations on pieces previously blanked or cut out in another press—an operator is required to feed each separate piece into the feeding mechanism.

As with all other machinery, simplicity and accuracy, combined with an increased output, are the prime essentials of automatic feeds for power punching presses. The illustrations accompanying this article show not only simple, accurate and positive automatic feed mechanisms, but in some instances, machines so nearly "human" that the operators simply sit idly by and "watch the machines do all the work." While the illustrations show the simpler types of automatic feeding devices, it is interesting to note that some of these devices have been perfected to such a degree that two or more of the various types of feeds mentioned are often combined in one press for automatically producing some of the most common hardware specialties—a case where rapid action, and consequent cheapness is very essential.

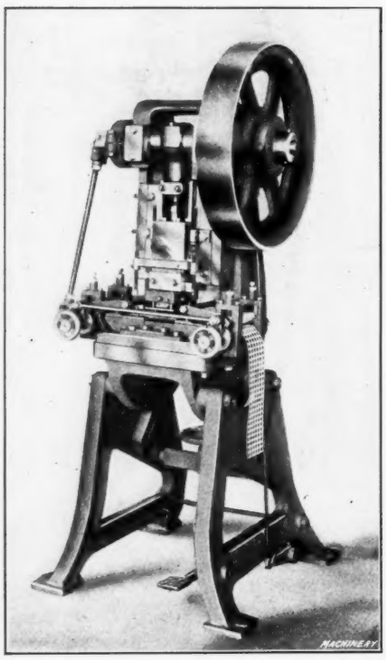

Fig. 1. Press with Double Roll Feed

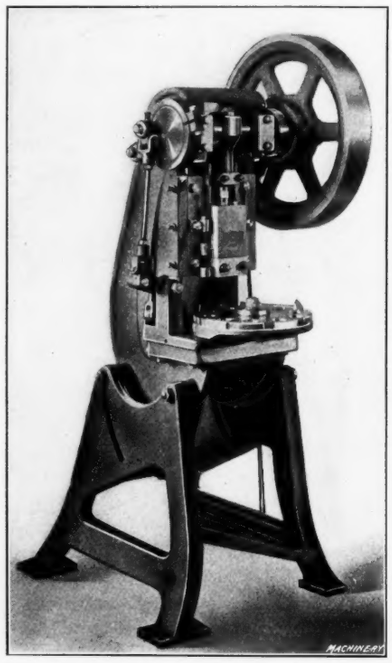

Fig. 2. Press with Dial Feed

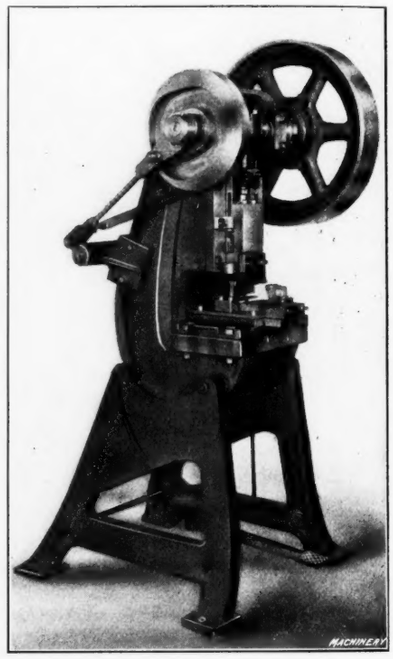

Fig. 3. Slide Feed Arrangement

Double Roll Feeding Attachment

Fig. 1 shows what is termed a double roll feed attached to an open-back inclinable power press. The press, when in use, is set on an incline, thus permitting the cut and formed work to automatically fall away from the dies by gravity. This style of feed is applicable to almost any type of press but, like most other feed mechanisms, it is adapted only to a limited range, namely work produced from a flat sheet or coil, either with plain blanking or cutting dies or with combination cutting and forming dies. Roll feeds consist of rolls of varying diameter and length, with a variable "feed-stroke," and while they insure accurate feeding and a saving in material, their actual value to each individual manufacturer depends primarily upon the size and shape of the article made, the construction of the dies, and whether single or gang dies are used.

The feeding device attached to the press in Fig. 1 is adjustable by sixteenths for feeding up to 1½ inch at each stroke of the press. The journals or boxes for supporting the rolls are adjustable to accommodate varying gages of metal. Pivoted releasing-levers or arms, bearing upward against powerful springs in each of the journals supporting the upper rolls, extend inwardly and under adjustable set-screws attached to the slide or ram of the press. Depending upon the manner in which they are attached, these roll feeding devices can be arranged to feed the stock from front to back or *vice versa*, or from right to left or *vice versa*. The stock is fed forward on the up-stroke or return of the shaft and slide, and as the slide descends, the set-screws mentioned, bearing down on the pivoted releasing-arms, lift up the upper rolls momentarily, releasing the pressure upon the strip of metal, so that, in the event of any unevenness in the thickness of the metal or any variation in the feeding, a pilot or guide-pin on the dies may locate the strip before the dies actually perform their work. The press and double-roll feed in Fig. 1, operating the gang dies shown, have a capacity for cutting six finished washers at each stroke of the press, running at 100 R. P. M.—an output of 360,000 washers per day of ten hours.

Fig. 4 shows a special double roll feeding mechanism operating on a straight-sided press equipped with gang dies for performing various operations on strip steel for expanded metal lath. The stock is fed into the machine in flat strips previously cut to the proper width. The first or forward set of rolls has a series of milled V-grooves for ribbing or V-ing the flat ribs longitudinally as they are fed into the machine. Passing from this first set of rolls into the dies, the strip is gradually slitted and expanded, and then automatically discharged by the rear set of rolls, which latter have, besides the V-grooves, a series of slots cut in them to match the shape of the stock that is slitted. This feeding device is adjustable for feeding up to 2 inches at each stroke of the press, the machine operating at 250 R. P. M.

* For further information on this and kindred subjects, see MACHINERY, August, 1911, engineering edition, "Design of Power Presses and Shears," and other articles there referred to. See also MACHINERY, September, 1909, "Simple and Automatic Stop-pins for Press Work," and "Two Feed-stops of Wide Utility"; and MACHINERY's Reference Book No. 13, second edition, Chapter V, "Stop-pins for Press Work," and Reference Book No. 26, second edition, Chapter VI, "Feed Stops for Presses."

Rack and Pinion Double Roll Feed

In Fig. 5 is shown a small open-back inclinable press fitted with another special double roll feeding mechanism. In this case, however, instead of having the eccentric or feeding arm connecting the cam on the shaft directly with the rolls, the drive is imparted from an eccentric on the shaft to a vertical-traveling rack, which, through its pinion and a series of bevel gears and an endless chain, acts as the drive for the rolls. This construction is what is termed a "rack-and-pinion" feed, and is resorted to in many cases where the work is of such a nature that it is desired to have the front of the press as open and free from arms as possible, to permit more ready accessibility to the dies and work. This is the prime reason for the use of this construction in this instance. The purpose of the press is the cutting out of corn plaster. The medicated cloth for the plasters, in strips about 4 inches wide and 48 inches long, is fed into the machine on a hard maple board of a slightly greater length and width, the board being fed forward about 1¾ inch at each stroke of the press. The work is performed by a group of hollow punches of the same construction as those regularly employed for cutting cloth, paper and other fibrous materials. Owing to the expense involved in the amount of unusable scrap or cut material, these dies are "staggered" or "zig-zagged" to permit cutting the plasters as close to each other as possible, thereby making use of the maximum amount of material in each strip. The first set of three punches cuts out only the center or "corn" opening, while, at the following stroke of the press, as the stock is fed forward, the second set of three punches cuts out

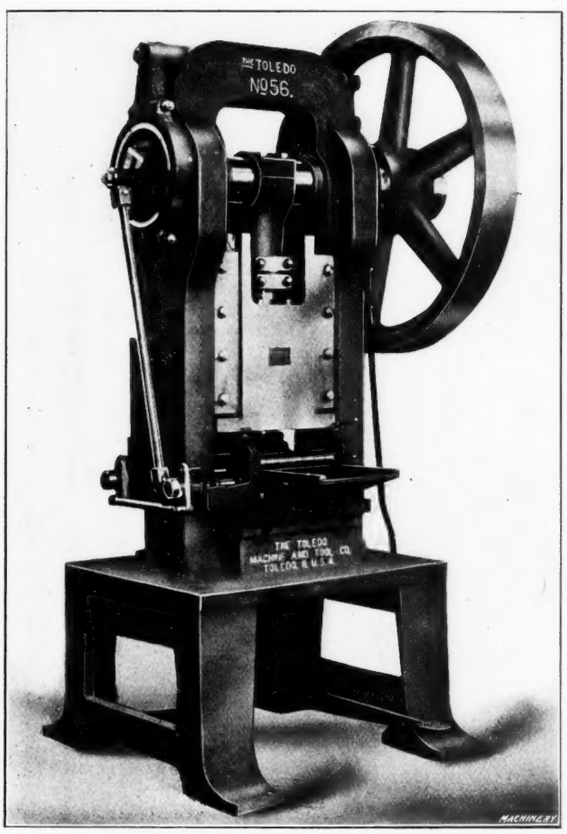

Fig. 4. Double Roll Feeding Mechanism attached to a Straight-sided Press

the completed cloth ring for the plaster. The punches for cutting the center opening are so constructed that the cloth is pushed up into them, and gradually automatically ejected through an opening in the back of the slide or ram to which the punches are attached. After the second operation the cut disks or rings are removed or stripped from the punches (or, more literally speaking, cutting dies); they are left on the maple board and taken back to the work-bench where the simpler operations are performed by hand to finish the plaster. In the meantime another board with its strip has been fed into the machine. The machine operates at 100 R. P. M., producing 300 rings per minute.

Dial Feeds

Fig. 2 illustrates what is designated as a dial or rotating feed, because of the fact that the work is automatically carried forward to and away from the dies by a continually revolving dial or feeding-table. This table is operated by a pawl and ratchet connected with an eccentric attached to the shaft of the press. The feeding dials are provided with holes varying in number according to the size and shape of the work and the size of the bed of the press to which the feed is fitted. Into each of these holes is fitted a tool-steel bushing or chuck

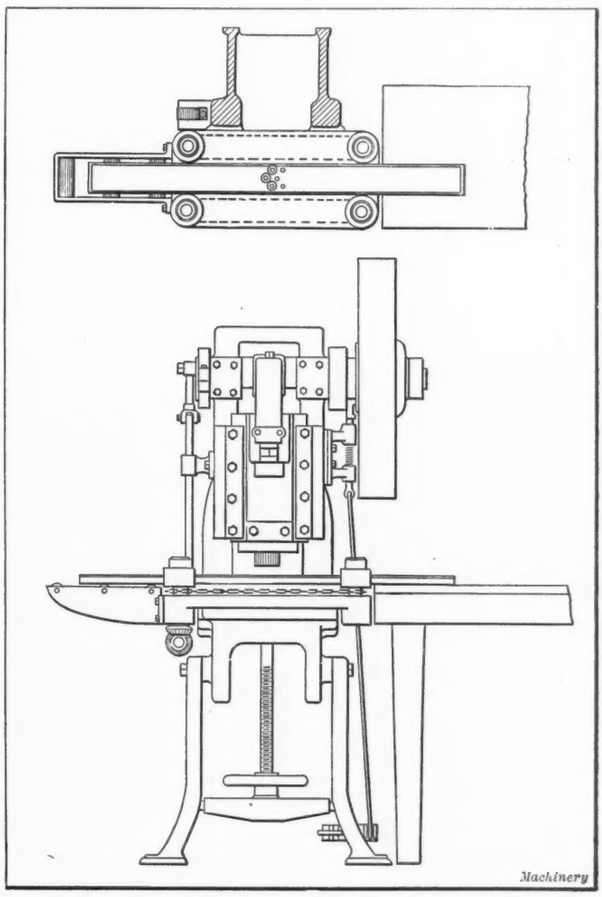

Fig. 5. Feed Arrangement used on Press for Cutting Corn Plasters

with a milled opening to match the shape of the piece to be operated upon. These bushings are removable, a different set of bushings being required for each shape or size of piece. To prevent the pieces from dropping through these openings in the bushings until the dial brings them to the dies, a stationary cast-iron plate is bolted onto the bolster or bed-plate of the press, directly beneath the revolving dial. This plate has only openings to correspond to the dies used. In some cases the cut pieces, ready to be formed, are automatically fed into the dial or rotating plate by a hopper or tube rigidly secured to the press bed. This, however, is feasible only on circular, square, or other regular shaped blanks. Irregular shaped blanks must in almost all cases be fed into the dial by hand, and as speed is the prime reason for the employment of this style of feed, it should be so arranged as to leave the front or feeding end of the press and feeding table as accessible as possible for the operation. This is the distinctive feature of the dial feeding mechanism shown in Fig. 2.

Dial-fed presses are widely used by manufacturers of curtain brackets, cartridges, torpedoes, locks, hardware, watches, and, in general, for articles requiring several forming operations, the dial feeding mechanism permitting of using gang dies for performing from one to four successive operations on certain classes of stampings in one press. One western telephone manufacturer uses one press fitted with a double-roll feed and ten other presses fitted with dial feeds for performing twenty-nine operations on a single stamping of light gage steel and of a very irregular shape.

The dial-fed press shown in Fig. 2 is also fitted with an automatic bottom lift-out (not shown) for ejecting the finished stampings from the dies, and with an automatic safety device attached to the trip-lever for the clutch, which automatically stops the press if the dial is not properly fed forward.

Coin and Hopper Feeds

The feed mechanism shown attached to a toggle-joint embossing or coining press in Fig. 6 was designed not only to

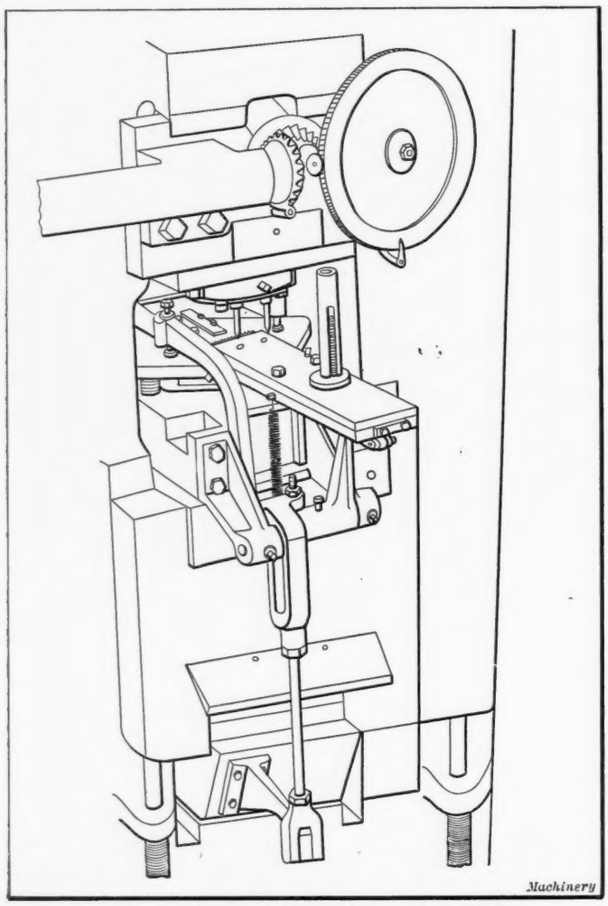

Fig. 6. Embossing Press with Coin or Hopper Feed

facilitate the feeding and discharging of blanks that were to be embossed in this press, but also with a view of reducing the danger of hand feeding. This feeding attachment is entirely automatic in its action, the operator simply keeping the hopper or receiving tube properly filled with blanks (flat cut disks). The disks are carried, singly, from the tube directly onto the lower die by means of the swinging arm shown, which extends downward and is secured to the lower knuckle or rocking arm for operating the slide or pressure-ram. This arm is adjustable, and so arranged that feed fingers to suit work of different size and shape can be readily attached to it. While a different feed-finger and tube are necessary for each different piece of work, few changes or adjustments are required for changing over from one size to another, the changes being made in about fifteen minutes. After being embossed, the work is automatically discharged from the dies and press by means of a spring collar and two pivoted feed fingers, the latter being actuated by the two tapered pins shown attached to the front of the upper die-holder. This feeding device, when attached to the style press mentioned, operates at about 50 strokes per minute, and will handle work ranging from about $\frac{3}{8}$ to 2 inches diameter. It can be used to advantage on regular-shaped work such as souvenir coins, medallions, trade-checks, telephone slugs, etc.

Slide Feeds

The feed mechanism attached to the small press in Fig. 3 is another "accident preventer," designed for use in connection with parts requiring forming operations, which, owing to the irregular shape of the pieces, make hand feeding necessary. Even experienced operators are at times careless in feeding or removing the work and, again, in starting the press. The slide feed shown eliminates accidents from such causes, as the only time that the operator's hands get into the dies is after the operation has been completed, the press stopped, and the dies returned to the front of the press for the removal of the finished piece, and the insertion of another. After placing the piece in the dies and "tripping" or starting the press, the dies are automatically carried back to their proper position under the forming punch by means of the toggle-arms connected to the cam and eccentric collar on the end of the shaft. This cam provides not only a positive, quick feed, but also a quick return of the dies to the front of the press after the work is finished. This style of feed is extensively employed in connection with the manufacture of small odd-shaped automobile radiator tubing, bottle caps, jewelry, and gas fixtures.

Chute and Hopper Feed

The development of the automatic manufacture of tin cans and articles of pieced tinware has brought out many automatic feeds and other press attachments. One of the most interesting automatic feeds for this class of work is that illustrated in Fig. 7. A horning and riveting press is here shown fitted up for automatically assembling and clinching together lard-pails and the ears for holding the wire which forms the pail-handle. Instead of the operator using one hand to hold the

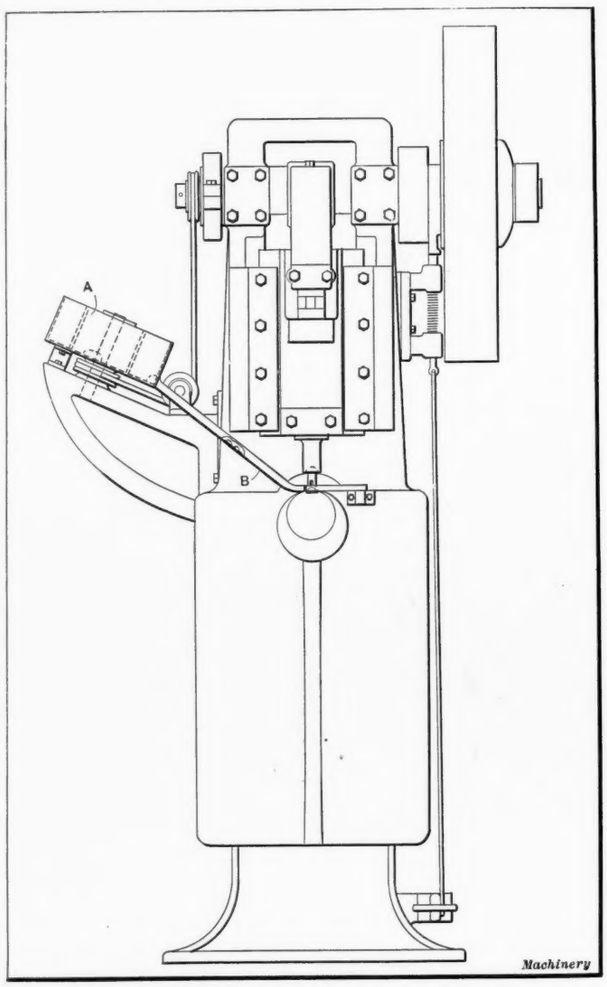

Fig. 7. Press with Chute and Hopper Feed Arrangement

pail and the other to place the ear on the clinching die, he merely places the pail on the die, which is attached to the horn or mandrel shown, trips the press, and the punch, descending on the pail and ear, the latter being previously fed to and located on the lower die, securely clinches the two tightly together. The revolving hopper *A* is filled with ears, and as it rotates the ears fall by gravity through the various openings in the side or wall of the hopper and into

the chute *B*. The chute does not convey the ears directly to the die, but to a point about 1¼ inch to the rear of the die. The press and dies are fitted with a sliding arm or feed finger located at the rear of the dies and connected with the slide or ram of the press proper by means of a pair of links. As the slide recedes from the work on the up-stroke, these links force the sliding feed-arm forward a fixed distance, and as the arm moves past the open end of the chute, it carries one ear forward and onto the dies. The arm remains in this position until the press is tripped. When the press is tripped and the slide descends, the motion of the links returns the feed-arm to its normal position at the rear of the dies, permitting another ear to slide down in front of it. This arrangement gives the operator the entire use of both hands, which is a big item in tinware factories where every operation is "piece-work." With the equipment described above, an operator can easily "ear" from three to four thousand pails per day of ten hours, each pail, of course, having two ears attached to it.

Automatic Perforating and Notching Devices

The automatic perforating and notching machines shown in Figs. 8 and 9 are of exceptional interest, and intended for unusual classes of work. Fig. 8 shows a horizontal perforating and notching press designed for perforating and notching gasoline tank-heads. The pieces to be operated on are centered and clamped in position between the clamping disks attached to the adjustable clamping arm shown. The press is then tripped, perforating a hole at each stroke of the press and running continuously until the entire periphery of the tank-head is perforated with rivet-holes, when the clutch is automatically disengaged and the press stopped. The finished work is then removed and another piece inserted. The press operates at a speed of about 100 strokes per minute, and has a capacity for work of from 24 to 60 inches diameter. Changes to suit different diameters of work and varying spacing of the perforations or notches can be quickly made.

Fig. 9 shows an upright perforating press and attachments for perforating the openings in the sides of strainer drums for cider presses. While this work could undoubtedly be performed more quickly "in the flat" by perforating several complete rows of the holes at one stroke in a wide double-crank press, two factors are to be considered in favor of doing the work shown in this smaller and necessarily slower press.

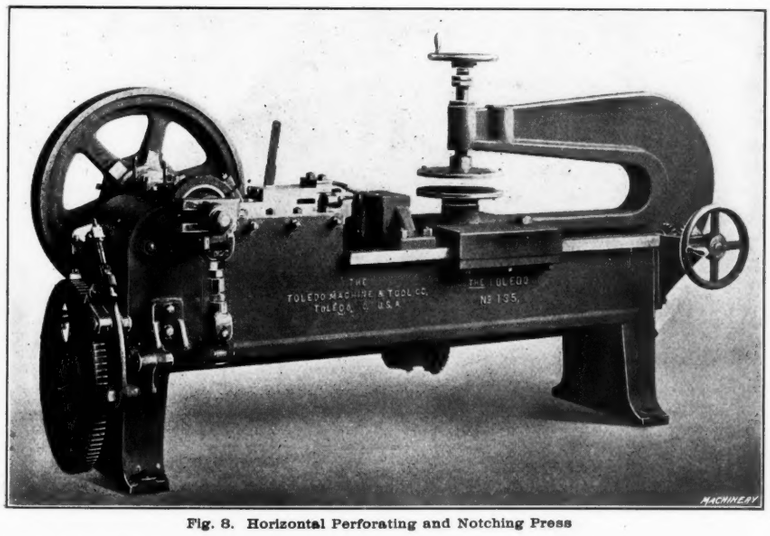

Fig. 8. Horizontal Perforating and Notching Press

One of these is that the flange, or that portion of the drum which is left solid (not perforated) is turned inward on the bottom of the drum, which requires that the balance of the drum also be left solid to prevent the slides buckling or wrinkling while the bottom flange is turned onto the cylinder; and the second is that this equipment is not only cheaper, but it is also so arranged that the automatic attachment can be removed and the press fitted with a bed, horn or other attachments for ordinary hand-fed operations such as blanking, forming, riveting, etc.

The flanged cylinder, after being placed over the perforating horn, is securely locked and held in place by means of the adjustable three-jawed chuck shown, the jaws of which are grooved to suit the different gages of metal in the lighter and medium sized drums. After locking these jaws, the press is started and continues in operation until the entire drum is perforated, when the clutch is automatically thrown out and the press stopped to permit the removal of the finished drum,

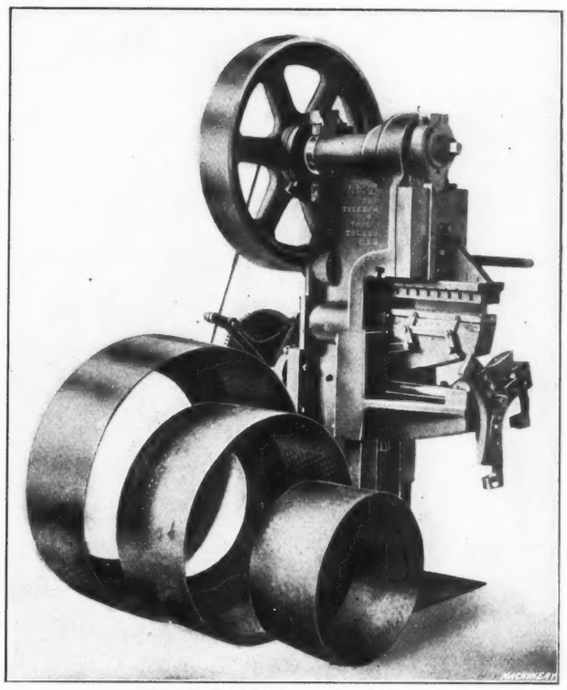

Fig. 9. Upright Perforating Press

and the insertion of a new one. The press makes 100 strokes per minute, perforating two rows of holes—top to bottom—at each stroke. The dies are inverted for the work referred to, that is, what is ordinarily the lower die is attached to the slide or ram, and the punch holder and punches are attached to the mandrel shown. An automatic stripper for stripping or removing the work from the punches is provided. This attachment, as well as the attachment on the press in Fig. 8, is fitted with an adjustable automatic indexing and feeding mechanism operated by a pawl and ratchet.

The automatically fed presses described are all labor-cost reducers and increased-work producers. While the initial cost of such equipment may sometimes appear high, it is, proportionately, no higher than that of other automatic machinery.

* * *

Several times in the past, the experiments carried on in Sweden for ascertaining the possibilities of the use of peat as a fuel in boilers, have been referred to in MACHINERY. According to the *Mechanical World* some experiments have now been carried out in connection with using powdered peat for firing boilers. For blowing the powder into the combustion chamber under a boiler, an electric fan was used. The air was heated in the smoke flues of the furnace to about 200 degrees F. previous to blowing, and it was possible to regulate the amount of air and powder with great precision. It was found that one ton of coal was equivalent in heating value to 1.397 ton of peat powder, the latter being of poor quality, and to 1.214 ton if better quality was used. The cost of raising the same amount of steam with peat powder and with coal compares as follows: The ton of coal necessary to raise the required amount of steam cost $3.96, and the 1.214 ton of peat powder required for the same amount of steam cost $2.76. In using the powder, however, some coal is required for the start, the additional cost being $0.50, bringing the total cost for the powder to $3.26, a saving of 17 per cent.

DESIGN OF DISHED SPROCKETS

By M. TERRY*

Eccentric design, or rather design of eccentrically loaded parts has always given and still gives considerable trouble to designers. While there is no reason why curved beams cannot be designed strong or rigid enough for the purpose, they are to be avoided whenever possible. A curious and perhaps the only exception to the above is to be found in the case of overhung bearings.

A typical case is shown in Fig. 1. *A* is a side member of a motor-car frame; *B*, a chain-driving sprocket; *C*, the driving shaft; and *D* a bracket bolted to the frame and supporting both the shaft and the sprocket.

If the sprocket alone be considered, the proper way to

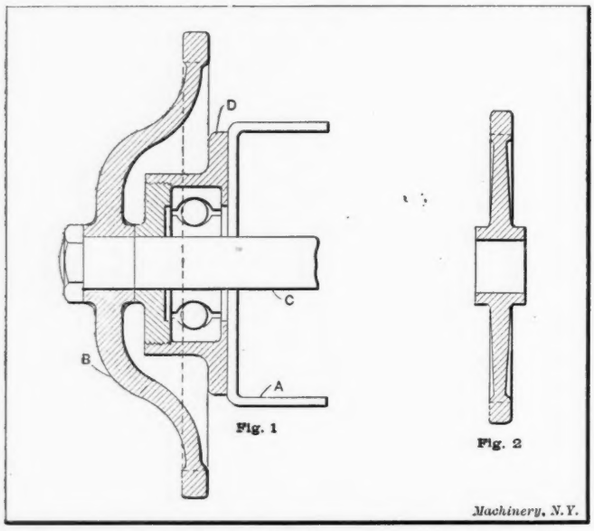

Fig. 1 Fig. 2

Fig. 1. Typical Example of Dished Chain Sprocket of an Automobile
Fig. 2. Plain Chain Sprocket

design it is to place the teeth in the plane of the web and have both symmetrical with the hub, as in Fig. 2.

The sprocket shown in Fig. 1 is practically a curved beam carrying an eccentric load; its web is subject to complex stresses, and it must be made heavier than the web in a symmetrical design. This offsetting of the web is known as "dishing." Webs are invariably dished in towards the supporting bearing.

The only disadvantage incurred consists, as pointed out above, in introducing complex stresses in the web, and the resulting necessity for heavier design. The amount of this disadvantage lies beyond the scope of the present article, and it will not be discussed in detail. The advantage of dishing consists in lessening the amount of bending moment due to the overhung load.

No attempt to develop general formulas applicable to all cases will be made, but a few simple cases completely worked out will sufficiently illustrate the principles involved.

Case 1. Fig. 3 shows a symmetrical sprocket with a cored hub. The total load of 1000 pounds is equally distributed at two points, *a* and *b*. The shear and moment diagrams follow from the load diagram. The case is very simple and no calculations need be given.

Case 2. Fig. 4 shows a dished sprocket with the plane of the load coinciding with the edge of the supporting wall; in all other respects it is similar to Case 1. It will be seen at a glance that on account of the eccentricity of the load with respect to the hub, there is a tendency for the sprocket to turn clockwise in the plane of the paper thus producing an upward pressure on the shaft at *a* and downward pressure at *b*. These pressures can be easily calculated. Calling the reactions of the shaft at *a* and *b*, R_1 and R_2 respectively, and taking moments about *a* gives

$$1000 \times 15 = R_2 \times 6$$

$$\text{Hence } R_2 = \frac{1000 \times 15}{6} = 2500 \text{ pounds upward.}$$

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Taking moments about *b* gives

$$1000 \times 9 = R_1 \times 6$$

$$\text{Hence } R_1 = \frac{1000 \times 9}{6} = 1500 \text{ pounds downward.}$$

These are the reactions of the shaft at *a* and *b*. The pressures on the shaft at the two points are equal to the respective reactions but opposite in direction. This explains the load diagram; the shear and moment diagram construction is based on the load diagram. The calculations involved are very simple and numerical results can be obtained by a mere glance at Fig. 4.

Case 3. This is identical with Cases 1 and 2, except that the load is applied 6 inches from the supporting wall, as shown in Fig. 5. To construct the load diagram, take moments about *a*.

$$1000 \times 9 = R_2 \times 6$$

$$\text{Hence } R_2 = \frac{1000 \times 9}{6} = 1500 \text{ pounds.}$$

Taking moments about *b*

$$1000 \times 3 = R_1 \times 6$$

$$\text{Hence } R_1 = \frac{1000 \times 3}{6} = 500 \text{ pounds.}$$

As in Cases 1 and 2, the shear and moment diagrams are self-explanatory.

These three cases differ from each other only in location

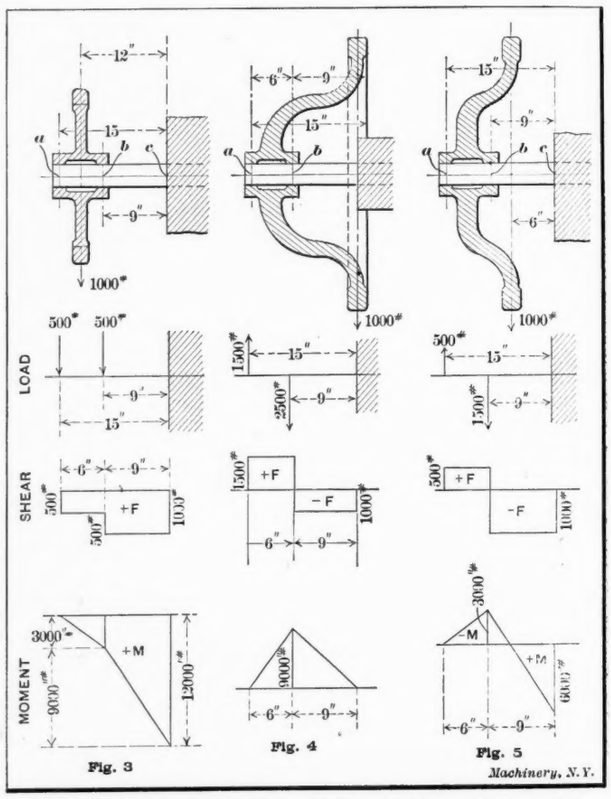

Fig. 3 Fig. 4 Fig. 5

Fig. 3. Plain Cored Chain Gear with its Load, Shear and Moment Diagrams. Fig. 4. Cored Chain Gear dished to have Drive in Plane of Support, accompanied by its Load, Shear and Moment Diagrams. Fig. 5. Cored Chain Gear with an Intermediate Amount of Dish, accompanied by its Load, Shear and Moment Diagrams

of the applied load. By comparing their bending moments it will be observed that:

In Case 1, the moment is positive and equal to 12,000 inch-pounds at *c*;

In Case 2 the moment is negative and equal to 9000 inch-pounds at *b*; and

In Case 3, the moment is negative at *b*, where it equals 3000 inch-pounds, and positive at *c*, where it amounts to 6000 inch-pounds.

It is evident then that the shaft is subject to less severe stresses in the third case than in the preceding two. The sprocket, too, has less offset in Fig. 5 than in Fig. 4.

It would then be of practical importance to know just how

much the sprocket need be dished in order to reduce the positive and negative moments on the shaft to the least possible values. By placing the load at various distances from a and constructing or calculating in each case the resulting bending moments, two curves can be plotted as in Fig. 6, representing moments at b and c. Their values are positive above the line AB, and negative below. As a matter of fact, the two curves are straight lines parallel to each other. At a

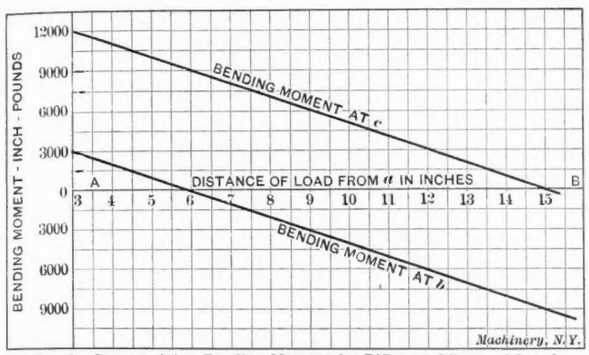

Fig. 6. Curves giving Bending Moment for Different Offsets of Cored Dished Wheels

point where the load is 10½ inches from a, the positive and negative moments are 4500 inch-pounds each; immediately to the right or left of this point one of the moments increases while the other decreases.

Cases 4 and 5, Figs. 7 and 8, differ from the others in the matter of distribution of load. The hub, it will be noted, is

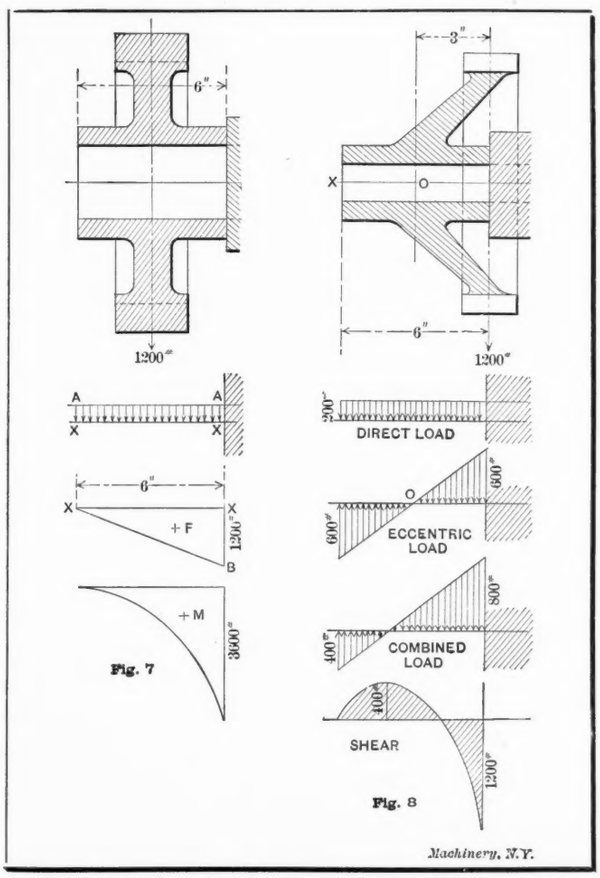

Fig. 7

Fig. 8

Fig. 7. Plain Gear with Load, Shear and Bending Diagrams. Fig. 8. Dished Gear with Direct, Eccentric and Combined Load, and Shear Diagrams

well fitted to the shaft, and the load is distributed throughout its length, whereas in the first three cases the hub was cored, and the load was considered as concentrated at two points. The total load is now 1200 pounds, and since the hub is located close to the supporting wall, Cases 4 and 5 constitute a group distinct from the one just discussed, and consequently no direct comparison of the two groups can be made.

Case 4. This design is merely a case of a uniformly loaded beam and is illustrated by Fig. 7. While the case in itself is very simple and does not require any laborious proofs and calculations, nevertheless a thorough discussion of it will be given for the sake of a better understanding of Case 5 which is far more difficult.

The load diagram is represented by a straight line AA parallel to the shaft, thus indicating that the shaft is everywhere equally loaded. Let the center line of the shaft represent the axis of XX; taking the origin at the free end of the shaft, the following equation for the load line can be written:

$$w = k$$

where w is the load at any point on the shaft in pounds per linear inch, and k is a constant. In this particular case $k = 1200 \div 6 = 200$. Therefore

$$w = 200 \text{ pounds.} \qquad (1)$$

By definition, the shearing force at any normal section of a beam is the algebraic sum of all the transverse forces on one side of the section. Therefore, the following equation for shear can be written:

$$s = \int w dx$$

Substituting for w its value from (1) and integrating

$$s = \int w\, d\, x = \int 200\, d\, x = 200\, x + c_1 \qquad (2)$$

To determine the constant of integration c_1, make $x = 0$; in

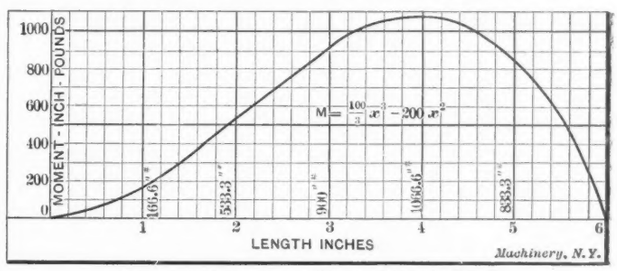

Fig. 9. Bending Moment Curve of Gear in Fig. 8

other words, apply equation (2) at the origin. The term $200x$ then drops out, its value becoming zero.

Therefore, $s = c_1$ when $x = 0$.

Remembering the definition of shear, it will be found that s at the origin is zero. Consequently $c_1 = 0$ and equation (2) reduces to

$$s = 200x. \qquad (3)$$

In the same manner as shear is a definite integral of load, moment is a definite integral of shear.

$$M = \int s\, d\, x = \int 200\, x\, d\, x = 100\, x^2 + c_2 \qquad (4)$$

To determine the value of c_2, make $x = 0$. Then $M = c_2$. But M at the origin is zero.

Therefore, $c_2 = 0$, and equation (4) reduces to

$$M = 100x^2 \qquad (5)$$

Comparing the load, shear, and moment diagrams with equations (1), (3) and (5) the following facts are noted:

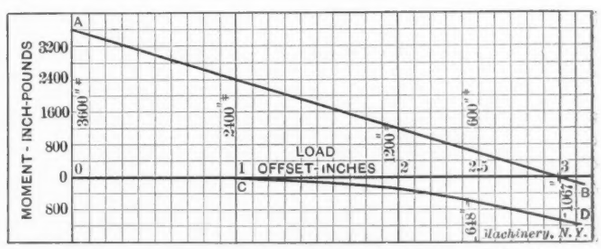

Fig. 10. Curves giving Bending Moment for Different Offsets of Dished Wheels

1. Line AA is everywhere equally distant from the axis XX; in other words, ordinates are independent of abscissas, which fact is represented by equation (1) where w is a constant and not a function of x.

2. The shear is represented by a slant line starting from the origin. Ordinates are everywhere directly proportional to abscissas which agrees with equation (3) $s = 200x$, where s varies directly as the first power of x.

3. The moment is represented by a parabola, which again agrees with equation (5), $M = 100x^2$ being the equation of a true parabola.

For the benefit of readers unfamiliar with analytical geometry and calculus, the following simple directions will be

found useful for constructing shear and moment diagrams and for determining shear or moment at any point.

The first part of the preceding discussion explains the construction of the load diagram; to find the numerical value of shear at any point take the corresponding point on the load diagram and then merely multiply the values of the ordinate (in the case at hand it is 200 pounds) by the distance of the selected point from the free end of the shaft. In other words, take the "area" of the rectangle in the load diagram bounded by *AA*, *XX*, the ordinate at the origin, and the ordinate at the point in question. Measure one side of the rectangle to a scale in pounds and the other in inches; the product gives pounds of shear at that point. For example at 6 inches from the origin, shear = 200 × 6 = 1200 pounds.

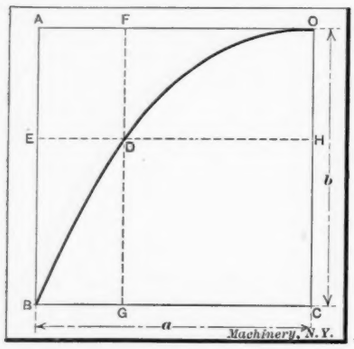

Fig. 11. Method of Determining Area of a Parabola or Portions of it

Having obtained a few of these values, and selecting any suitable scale (say 100 pounds = 1 inch) lay off ordinates at various points on the shaft proportional to the values of shear at those points, and the shear diagram is thus obtained. An actual trial will prove it to be a straight inclined line.

The moment diagram can be constructed from the shear diagram in precisely the same manner as the latter was constructed from the load. For example, to find the value of moment 6 inches from the origin take the "area" of the triangle formed from the origin up to the 6-inch point, in this case at the wall:

$$M = 1200 \times 6 \times \tfrac{1}{2} = 3600 \text{ inch-pounds.}$$

At 3 inches from the origin,

$$M = 600 \times 3 \times \tfrac{1}{2} = 900 \text{ inch-pounds.}$$

In computing the "area" of the shear triangle, measure ordinates in pounds, and abscissas in inches, the product giving inch-pounds.

Case 5. This is identically the same as Case 4 except that the load is now offset 3 inches to the right of *O*, the center of the hub; *i. e.*, it is in line with the edge of the supporting wall as in Fig. 8.

The problem of loading can be broken up into two parts: 1, pressures on the shaft due to direct load; and 2, pressures on the shaft due to the eccentricity of the same load. The direct load being 1200 pounds, the pressure per linear inch is 200 pounds and this part of the load diagram is precisely the same as in Case 4.

It is clear that owing to the eccentricity of the load, the gear in Fig. 8 has a tendency to rotate clockwise in the plane of the paper, producing upward pressures on the shaft to the left of *O*, and downward pressures to the right of it; these pressures are assumed to be proportional to their distances from *O*. They are maximum at both ends of the hub and gradually decrease to zero at *O*, thus forming two triangles of pressures. The resultant of each triangle is located, of course, two-thirds the distance of the extreme pressure from *O*, *i. e.*,

$$2/3 \times 3 = 2 \text{ inches.}$$

The two resultants then form a couple or moment whose value is $R \times 4$ inch-pounds where R is the value of either resultant in pounds, and 4 is the distance between the resultants in inches. This moment is produced by the eccentricity of the applied load (1200 pounds), and must be numerically equal to the moment of the latter about *O*.

Therefore,

$$R \times 4 = 1200 \times 3$$

or

$$R = \frac{1200 \times 3}{4} = 900 \text{ pounds.}$$

If F is the pressure at X in pounds per linear inch, then

$$F \times 3 \times \tfrac{1}{2} = R = 900 \text{ pounds.}$$

or

$$F = \frac{900 \times 2}{3} = 600 \text{ pounds.}$$

The two load diagrams can be combined algebraically into one, as shown in Fig. 8 and the load line thus obtained can be represented by the following equation:

$$w = 200x - 400 \qquad (6)$$

where w is the load in pounds per linear inch at any point on the shaft, and x is the distance in inches of that point from the unsupported end of the shaft.

Applying the same method as in Case 4:

$$s = \int w dx = \int 200\, x dx - \int 400\, dx$$
$$= 100x^2 - 400x + c_1$$

When $x = 0$, — $s = 0$ and therefore $c_1 = 0$

Then,

$$s = 100x^2 - 400x \qquad (7)$$

Again,

$$M = \int s dx = \int 100\, x^2 dx - \int 400\, x dx$$
$$= \frac{100}{3} x^3 - 200x^2 + c_2$$

When $x = 0$, — $M = 0$, and therefore $c_2 = 0$

Consequently $M = \dfrac{100x^3}{3} - 200x^2 \qquad (8)$

Shear and moment diagrams can now be constructed from equations (7) and (8).

The reader may find it profitable to compare Figs. 7, 8 and 9 as well as equations (1), (3), (5), (6), (7), and (8), and draw a few conclusions of his own.

The shear and moment diagrams can be also constructed by the "area" method as outlined in Case 4; care, however, must be exercised in interpreting the results and assigning to them the proper signs, positive or negative.

In finding areas of parabolas or portions of them, the following will be of assistance: In Fig. 11, *ODB* is a parabola with vertex at *O*.

Area $ODBCO = 2/3ab$

Area $AODBA = 1/3ab$

Area $EDBE = 1/3ab - AE \times ED - 1/3\ OF \times FD$

Area $DBGD = 2/3ab - GC \times CH - 2/3\ OH \times DH$

Fig. 9 represents the bending moment diagram constructed from equation (8). It will be observed that the maximum moment amounts to only 1066.6 inch-pounds, as against 3600 inch-pounds in Case 4. (See Fig. 7.) As this reduction is considerable, it is of practical value, and a further investigation might disclose an offset which is accompanied by a further decrease of the bending moment. By selecting various offsets and obtaining maximum moments in each case by methods outlined in Case 5, two curves as in Fig. 10 may be plotted.

The line *AB* represents moments at the edge of the supporting wall, while the curve *CD* represents maximum negative moments on the shaft caused by varying load offsets. It might be added that these maximum negative moments do not occur at the same point on the shaft, but vary with the offsets.

By consulting Fig. 10, it will be observed that when the load is offset 2½ inches to the right of *O*, the moment at the wall is positive and is equal to 600 inch-pounds, while the negative moment amounts to 648 inch-pounds. The ideal offset is somewhat less than 2½ inches, but its exact value is of little practical use, since the ideal (*i. e.* the least) moment lies between 600 and 648 inch-pounds, and further investigation is not worth the trouble.

In conclusion the author wishes to state that there is a very prevalent notion among designers that by offsetting sprockets, gears, etc., so as to bring the plane of the load in the plane of support—the bending moment on the shaft is entirely eliminated, just as if the load were applied directly at the point of support. Time and again the author came across this idea, and it prompted him to look into the matter. He hopes he was successful in proving the utter fallacy of this idea and he further hopes that his investigation (based on accepted theories) reveals the fact that in "dishing" to attain the best results, the load need not necessarily come in the plane of support.

SOME INTERESTING MECHANISMS*

AS USED ON AUTOMATIC MACHINES FOR VARIOUS PURPOSES

By GEORGE W. ARMSTRONG†

The text of this article is, in the main, descriptive of cam applications, ratchet and star-wheel combinations, and reversing devices, illustrated by the accompanying line engravings. A heterogeneous collection of uncorrelated mechanical movements such as follows naturally cannot be classified, being garnered, as they are, from various sources in the hope that they may prove of interest and be instructive. As examples of inventive design—which term is used advisedly instead of machine design—these are presented for their suggestive value to the reader, rather than because they possess intrinsic value to other than those primarily interested. The writer's personal experience has been that knowledge gained by studying concrete examples of mechanisms or mechanical powers is vastly more beneficial toward a thorough understanding of the fundamental principles involved, than a much more extended study of abstract theories, with perhaps, finally an incomplete conception of the possibilities of combinations. The study, *in situ*, of a mechanical element of some complicated machine, in its functional relations to the organism as a whole, is undoubtedly most interesting and advantageous; but as such opportunities are seldom presented, a greater familiarity with the usage of the laws underlying applied mechanics may be gained from a perusal of the matter appearing, from time to time in the technical press.

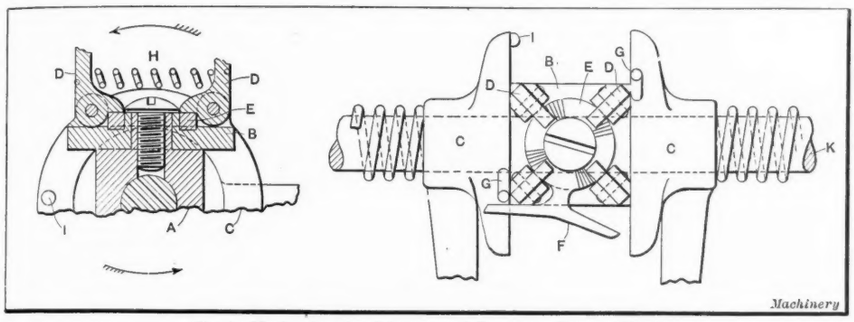

Fig. 1. Mechanism for Gripping and Turning a Piece of Work

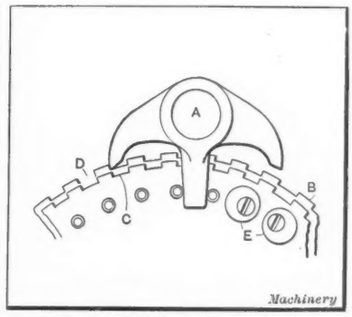

Fig. 2. Ratchet Reversing Mechanism

Mechanism for Gripping and Turning a Piece of Work

A piece of work operated upon in two positions within the machine producing it was required to be rotated 90 degrees between the operations. Fig. 1 illustrates a mechanism which successfully handled work from 1½ down to ¼ inch diameter at from 30 to 60 revolutions per minute. Upon a double stud-block *A* are mounted two turn-tables (one seen at *B*), which are held in the same position, relative to each other, by the non-revolving collars *C*. These collars are free to slide along the shaft on which they are mounted, but are held up against the turn-tables by springs. As each turn-table approaches and recedes from the work, the toes of the grippers *D* are raised and lowered by the cam ring *E* (not unlike a universal chuck ring) which is provided with a double tappet *F*. This tappet, acted upon by pins *G*, provides means for gripping the work while the shaft *K* and the mechanism rotate. Continued rotation of the shaft brings *B* into engagement with projection *I*, thus turning the table *B* through an angle of 90 degrees, meanwhile forcing the collars *C* apart to permit the table to turn. Each table is returned to its former position while the other is indexing the work, thus avoiding the necessity of indexing to four positions. Spring *H* holds the toes of grippers *D* against cam *E*.

Ratchet Reversing Mechanism

An arrangement whereby a ratchet automatically reverses after making a predetermined number of revolutions was required, with the further condition that the time of reversal, or, what amounts to the same thing, the number of revolutions, might be varied at will through a wide range. Referring to Fig. 2, the double pawl *A* is carried by a reciprocating member (not shown) over the driving ratchet *B* and the controlling ratchet *C*, which latter is normally frictionally restrained from rotating. The larger diameter of *B* precludes the pawl engaging *C* except at such times as the deep notch *D* is reached. The two adjustable trip dogs *E* and the finger on the pawl accomplish the reversal, and the position of the former, together with the number of deep notches, determines the time for quicker reversals.

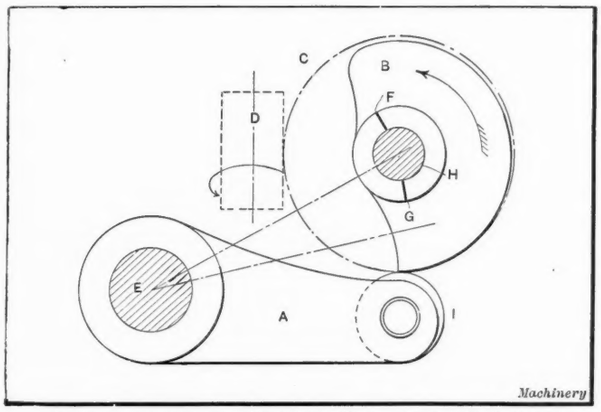

Fig. 3. Arrangement for Eliminating Chatter in Cam Mechanism

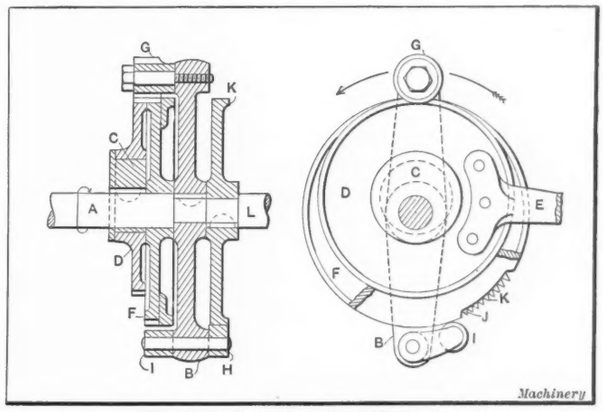

Fig. 4. An Intermittent Feed Mechanism

Arrangement for Eliminating Chatter in Cam Mechanism

An unforeseen difficulty and the expedient adopted to overcome it may be noted in Fig. 3. Here *A* is a stationary lever and *B* is a cam mounted upon the same shaft as worm-wheel *C*, which is driven by a triple-threaded worm *D*, the whole arrangement being pivoted on shaft *E*. The cam made from 25 to 100 revolutions per minute, and at the slower speeds its drop on the roller from the high to the low dwell was attended, with excessive chattering, the vibrations being disastrously magnified at a distant point, while the noise was decidedly objectionable. This was probably due to a slippage between the worm and gear while the drop of the cam was on the roll. In this position the thrust upon the worm was reversed, and this caused a tendency in the gear to gain on the worm by small jumps, so that a slight back-lash was exaggerated to a marked extent.

Various attempts to overcome this proved unsuccessful until

* See also MACHINERY, July, 1908: "Cam Applications."

† Superintendent, Lester & Wasley Co., Inc., Norwich, Conn.

the cam was left free upon the shaft and a clutch formed on the hubs of the cam and the worm-gear with the teeth *FG* and *FH*. A gap *GH* was left, slightly larger than necessitated by the time allowance for dropping, so that the cam was free to rotate ahead of the driving gear and give an instantaneous drop. A resulting advantage was a motionless low dwell.

An Intermittent Feed Mechanism

The solution of an interesting problem is indicated in Fig. 4. For every 1¼ revolution of a continuously rotating shaft, a second shaft in the same line must rotate intermittently with like velocity in the same direction through an angle of 30 degrees. Keyed to the driving shaft *A* are the double arm *B* and the eccentric bushing *C*. Loosely mounted on *C* is a 96-tooth gear *D* which is restrained from rotating by *E*, but whose pitch line, because of the eccentricity of *C*, is always

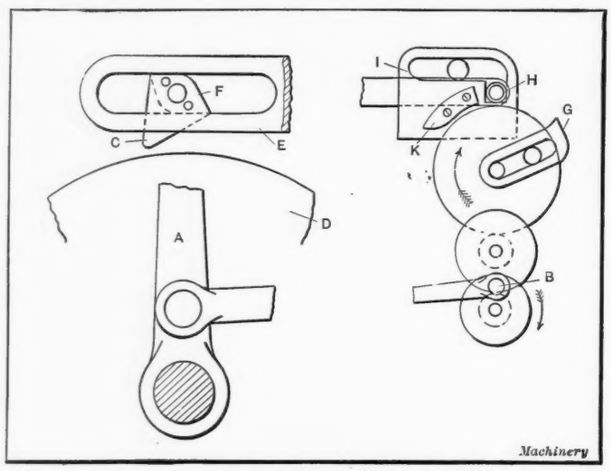

Fig. 5. Feed Mechanism with "Skipping" Device

tangent to that of the 120-tooth gear *F*, and to the planet pinion *G*. As the arm *B* carries the pinion around *D*, the gear *F* is revolved on *A* in the ratio of 120 to 96 or 1.25 to 1. The end of *B* opposite the pinion carries a link and roller *I*, which runs on a flange of gear *F* until a break *J* in the periphery allows it to drop and pawl *H* to engage ratchet *K* keyed to shaft *L*, thus turning the ratchet forward till the roll mounts the flange again. Since *F* advances one-fifth of a revolution per each revolution of the arm and pawl, and since 30 degrees equals one-twelfth of a revolution, the opening for the roll must be shortened 1/5 × 1/12 of 30 degrees, or to 29 1/2 degrees.

Feed Mechanism with "Skipping" Device

The simple arrangement in Fig. 5 was devised to skip a feed in a ratchet according to any requirements. The arm *A*, oscillated by the pitman *B*, carries a stud on its free end upon which is pivoted a fiber pawl *C* engaging the smooth periphery of the disk *D*. The slotted bar *E* controls the pawl, to frictionally engage the lower side of the slot. The result of any motion of the arm *A* toward the right is to give the pawl the position shown, that is clear of the disk *D* for the return stroke, the shape of *F* limiting the back-lift of *C*. The reverse motion of *A* tends to reverse the position of *F*,

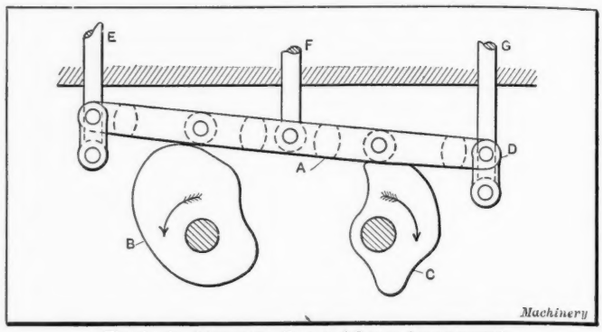

Fig. 6. An Interesting Cam and Lever Arrangement

the friction between *C* and *E* constraining the pawl to grip the disk and to rotate it, thereby feeding the required amount. The skipping of a feed is accomplished as follows: Through the train of change gears and the cam *G*, the pawl *H* is lifted clear of its seat and is free to slide horizontally, introducing

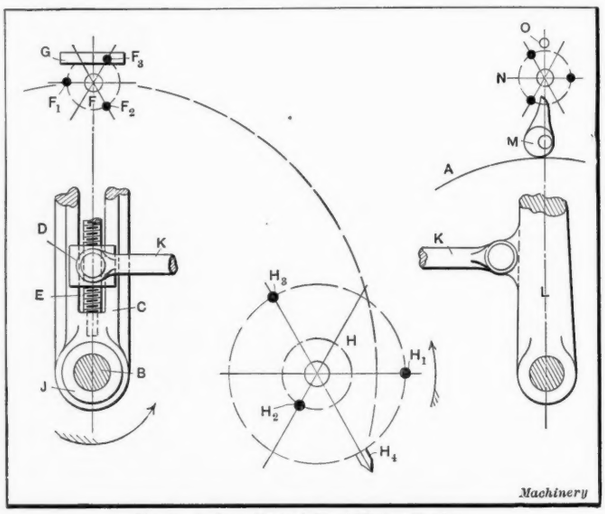

Fig. 7. A Complicated Feed Motion Device

no frictional resistance in the pawl and leaving it clear of the disk. Cam *G* is pushed in when it strikes dog *K*, and is suddenly thrown out by a spring after having passed the dog. Its release disengages *H*, which is reseated, upon the return of the bar *E*.

An Interesting Cam and Lever Arrangement

In Fig. 6, lever *A* and two cams *B* and *C* are shown. This combination is a curious and rather paradoxical arrangement,

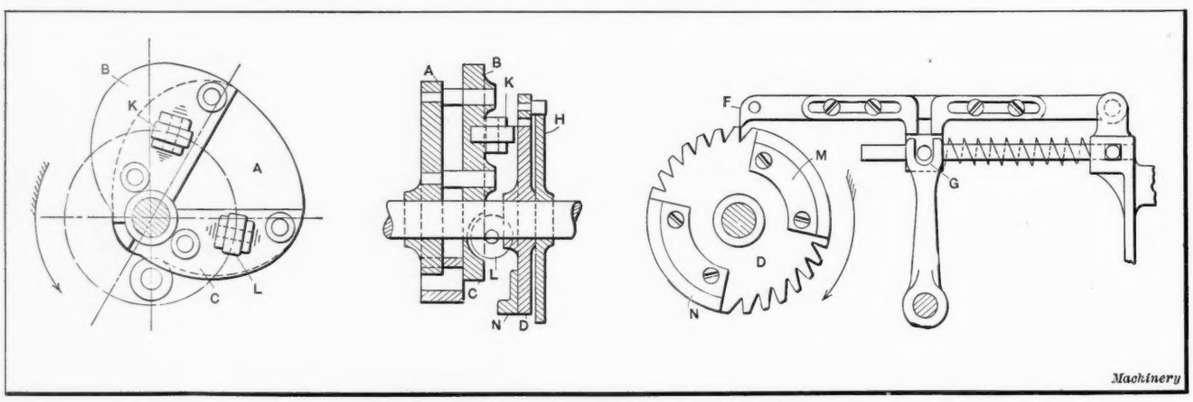

Fig. 8. An Automatically Adjustable Cam Mechanism

which is made of two pieces screwed to opposite sides of the lozenge shaped piece *F*. The latter being within the slot and slightly thinner than the bar, causes the projecting parts of *C* introducing levers with two shifting fulcra. At times the lever is one of each of the three orders of levers, sometimes different pairs of the orders, and sometimes combines all three

together; at times it is not a lever at all. Any kind of motion may be obtained for the outer rods, but if rod *F* is to remain motionless while *E* rises, cam *C* must follow the movement obtained from *B* in proper ratio. An analysis of the case shows an apparent paradox of a weight and fulcrum being at *D* and the power applied at *B* or *C*, or a fulcrum being at *C*, the power being applied at *B*. If both cams impart the same amount of motion to *A*, but in opposite directions, then the point where *F* is pivoted to the lever becomes the apparent fulcrum. During an equal simultaneous rise of both cams, *A* is not a lever in the ordinary meaning of the word.

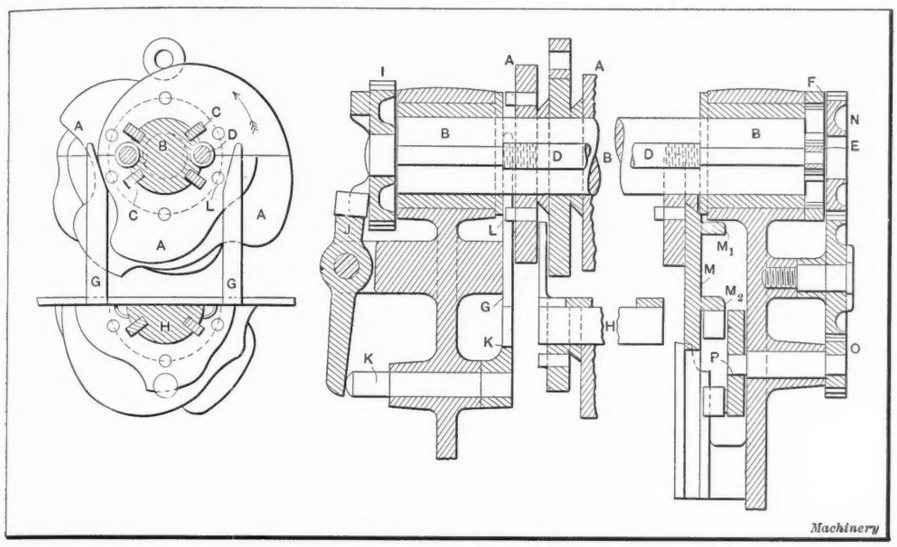

Fig. 9. Interchangeable Cam Mechanism

A Complicated Feed Motion Device

A somewhat complicated feed system was to be designed and it was desired to obtain the motion from a shaft running with twice the desired speed. The end in view was to rotate the ratchet *A*, Fig. 7, for every other revolution of shaft *B*, through a small arc which should increase by small increments until the maximum feed was reached, decreasing thereafter to the minimum, and then increasing again to the maximum, at which point the feed should instantly begin at the minimum again; that is, there should be two periods of increasing feed and one period of decreasing feed for every cycle.

In the partially diagrammatical view Fig. 7, *C* carries a sliding block *D*, connected to *L* by a pitman *K*. Block *D* is fed to or from the center of *B* by screw *E*, working in a divided nut. On the upper end of *C* are two intermittent motion star-wheels *F* and *G*, of six teeth each, with their planes at right angles. Wheel *F* is pivoted on the side of *C*, and *G* is fastened onto *E*. Wheel *F* has three projecting pins F_1, F_2, and F_3, placed on alternate teeth and denoted in the illustration by large black dots. Suppose star-wheel *F* is rotated one tooth (denoted by the straight lines). If that tooth is one of the three with the projecting pins on the side, wheel *G* and screw *E* will be rotated one-sixth of a revolution. Conversely, if the tooth on *F* has no projecting pin, *G* will not rotate. This scheme gives the alternating feed through *K* and *L*, as the arm *C* revolves about the center of *B*.

The center of *F* revolves about *B* in a path as shown by the broken line, which passes midway between the two circles at *H*. These circles represent the controlling star with six teeth or points (denoted by straight lines). A pin (not shown) upon the block *D* is caused to engage two teeth of *H*, on two successive revolutions before it is retracted. This is done only when the slide is at the upper end of its travel. Star-wheel *H* merely operates star *F*. Three projecting points (denoted by black dots) engage point after point of *F* as it comes around.

Suppose it is projections H_1 or H_3 that engage with *F*. Then by reason of their being on the outer side of the center of *F*, star-wheel *F* must revolve in an opposite direction to that in which it would revolve if H_2 was the projection engaging *F*, because H_2 is on the inner side of the center path of *F*.

From the description of the mechanism given it is now apparent that block *D* moves up (or down) through the action of *H* upon *F* and *F* upon *G*; and the motion takes place only for every other revolution of *B*. When block *D* reaches the outer limit, the pin upon the block is released as mentioned, which, in turn, revolves *H* two teeth before it is retracted, thereby engaging the opposite side of *F*, reversing the direction of rotation of *F* and *G* and returning *D* toward the center. Pin H_3 is here brought into action and *D* goes outward again to the extreme position. The controlling star is rotated as before, returning H_1 to position and bringing H_4 into action to open the split nut at screw *E*, which allows a spiral spring in *J* to return the block *D* and pitman *K* instantly to the center, thus completing one cycle.

Through link *K*, lever *L* and pawl *M*, ratchet *A* is rotated. A star *N* is carried by *L*, which is operated by the hinge tappet *O* and which is provided with three projecting pins to lift the eccentric pawl from the ratchet every alternate stroke of *L*.

An Automatically Adjustable Mechanism

A certain cam, normally has a 120-degree rise, 60-degree dwell, 90-degree drop, and 90-degree dwell. If, however, the pressure exerted in another part of the machine, during a dwell, exceeds a given limit, the rise must take place in 90 degrees; and the drop must be lengthened to 120 degrees, if the pressure decreases below that desired. Fig. 8 shows the mechanism used for accomplishing the object desired. Slidably mounted upon cam *A* are two auxiliaries *B* and *C*, of the proper angularity, each carrying a roller *K* and *L*. There is also a disk *D* with two sets of ratchet teeth and two side cams

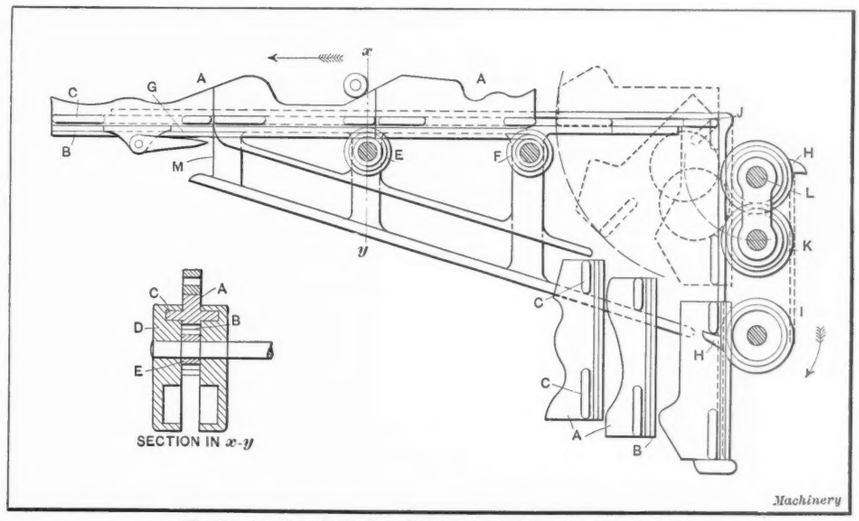

Fig. 10. Another Method of Obtaining Same Results as in Fig. 9

M and N. A pawl F rests upon the block G until the increase or decrease of pressure outbalances the spring, at which time F drops into the ratchet. The latter then ceases to rotate, and M and N force cams B and C to the left, where they engage with the wide cam roller. Cam H returns pawl F to the neutral position.

Interchangeable Cam Mechanism

Two distinct methods of obtaining practically identical results were successfully evolved for a certain purpose, and as they exhibit great diversity of construction and are somewhat novel in design, they are illustrated in Figs. 9 and 10. The requirement in each case was a flexible cam system which could be readily changed with relation to any one movement by substituting another cam section, which would occupy less space than would a single large cam. One solution of this problem made use of rotary motion, while the other involved the use of rectilinear motion for the cam. Both mechanisms might properly be termed "magazine" cams, because the parts composing them were continually placed in action and then replaced by others in successive order. The cams in Fig. 9 are semicircular, as shown at A. The continuity of the cam surface is obtained by making each semicircular section in the form of a half turn of a spiral with close-fitting joints, the complete cam appearing like a worm. The sections are fed longitudinally along the shaft and successively under the lever roller at a rate of advance equaling the lead of the spiral. Four feathers C are provided to guide and retain the cams. The two screws D producing the longitudinal movement, are driven by pinions E meshing with an internal gear F, which is fastened to the bearing. As the feathers extend only to within the width of one cam from the left bearing, it follows that two sections drop from the shaft at every revolution, the dropping sections being guided by the guides G. The double cam upon the driving gear I, the lever J, and the carrier-slide K, provide the means for hanging the semicircular cams upon the magazine bar H. The slide K catches each piece by the pins L and, by pushing one, causes the further one to be slid onto the lifting slide M which engages its grooved hub. The gears N and O, in the ratio of 1 to 2, and disk P operate a slide for returning the cams to their shaft. The rollers on P successively engage the steps M_1 and M_2, thus raising the slide which drops back automatically.

To facilitate engagement between the cam threads and the screws, the square threads of the latter are brought to a V at the entering ends, and to insure instantaneously positive locking of the cams to the shaft, the ends of the feathers recede into pockets and fly out by the action of springs. Any part of the system may be changed by placing the desired section in a holder and introducing it between the slide K and the magazine bar. The cam to be removed—the dropping cam—comes out upon an inclined runway of the holder.

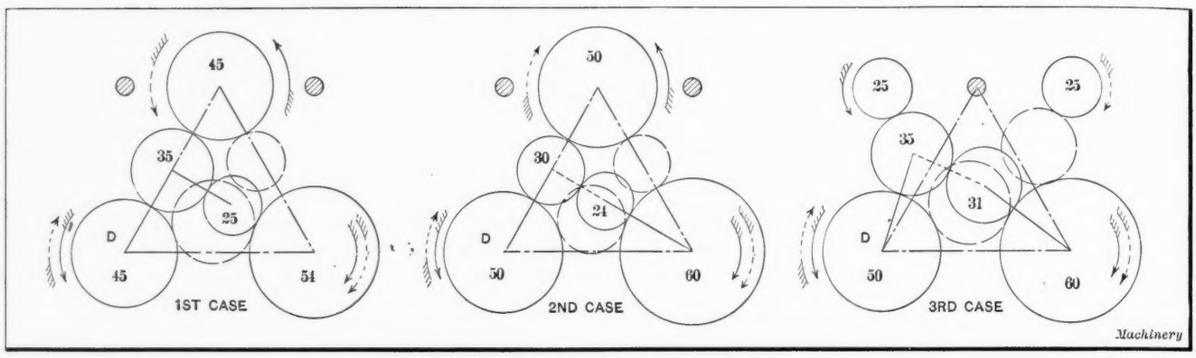

Fig. 11. Reversing Gearing Arrangements

The alternate design is the rectilinear cam system shown in Fig. 10. The mechanism consists of the cam section A, provided with rack teeth at B. Each section has four lugs C which act as guides in the ways D. A pinion E feeds the sections along beneath the lever roller, and the frictionally driven pinion F assembles them. When any section has passed beneath the roller, it is automatically hung upon the magazine chute. The forward lugs C are made slightly longer than the rear ones, to span the gap G; but the rear lugs enter the gap just as the forward lugs clear the ways. The sections are taken from the lower part of the ways in the magazine by spring-controlled forks H upon the chain I which engage the lugs and lift the cams until the smaller lugs abut at the corner J. The linked gear K meanwhile engages the rack, and as it swings about the center L, it lifts the cam up against the ways. Here the resistance offered to further motion of the links causes K to rotate about its own center and slide the cam into place. Substitute sections are introduced at M, and the replaced sections are lifted from the ways.

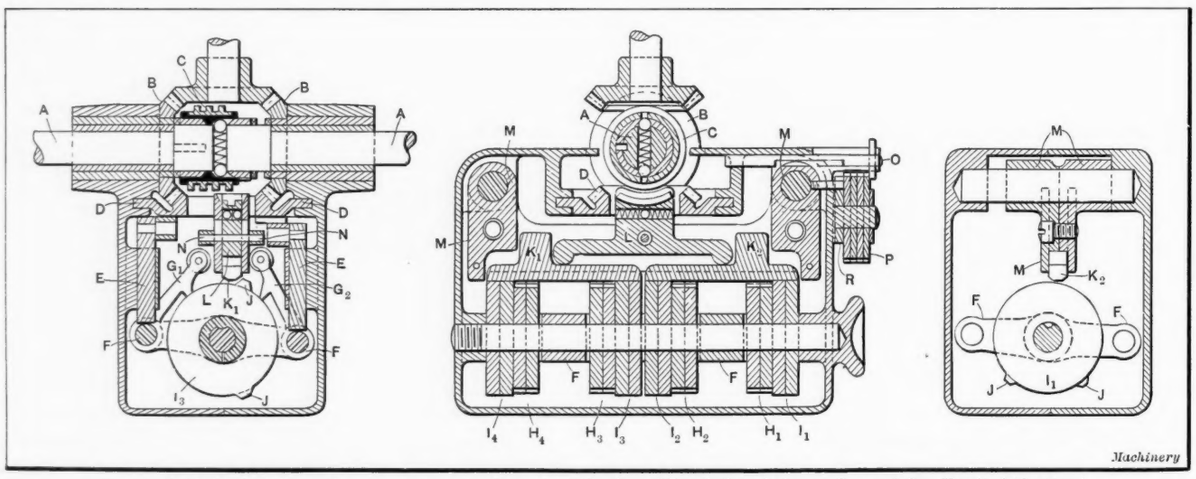

Fig. 12. A Mechanism that will reverse at any Predetermined Number of Revolutions between One and One Hundred Thousand

Reversing Mechanisms

Fig. 11 shows three diagrams of automatically reversing systems of gearing, employing self-operating tumblers; Fig. 12 shows the controlling elements of the combination. The requirements were (see Fig. 11): 1.—That a reversing gear should drive two others continuously in the same direction,

but in opposite directions relative to each other. 2.—That a reversing gear should drive one of two gears continuously in the same direction and the other in the same direction as that of the reversing gear. 3.—That a reversing gear should drive one gear continuously in the same direction and should drive two others alternately in the same direction as itself.

The reversing driver is D. The full arrows and full circles should be read together, and likewise the broken lines. The full lines connecting centers indicate that those gears are linked, and the broken lines denote spring connections. The moment of the reversing driver and the friction of the links swing the idlers.

The means for accomplishing the reversal of the shaft automatically is of special interest; the shaft must reverse after completing the desired number of revolutions, which number may be anything below 100,000, and it must cease rotating when it shall have completed the required number of reversals, which may vary up to 10,000.

The reversing shaft seen at A, Fig. 12, is driven through the medium of the miter gears B and the sliding worm-clutch C. A miter gear D has a cam to engage the rollers on the upper ends of bars E, the lower ends of which oscillate the rockers F. These rockers carry two sets of pawls G_1 and G_2, each provided with a roller as shown. The set at the left is now in action upon the oppositely cut pairs of ratchets H_1, H_2, H_3, and H_4, which operate the disks I_1, I_2, I_3, and I_4, each of which is provided with a cam J. This system of cam disks and ratchets is the "combination." Each ratchet has twenty teeth with one deep cut. Each tooth of H_4 equals 8000 revolutions; of H_3, 400 revolutions; of H_2, 20 revolutions; and of H_1, one revolution. To set the combination for 49,763 revolutions, set H_4 at six, H_3 at four, H_2 at eight, and H_1 at three teeth. Each group of two ratchets and two disks are independently arranged, and the four units are then assembled.

Now, with the desired setting, the operation is as follows: G_1 drops into a deep notch of H_1 after a number of teeth, and allows the next pawl to turn H_2 one tooth; this is continued until eventually I_4 is brought to the position where its cam is at the top. This lifts the floating lever K_1 at the left end and the lever L one-half as much. When the other cam disks shall act upon K_1 and K_2 these and L are lifted the full amount and the spring balls in L throw it quickly into mesh with the worm C, the upper edge of L being formed as two threads. K_1, K_2 and L, being contained in carriage M, are all constrained to move to the left because of the action of C. This results in breaking the combination; that is, the floating levers are all removed from the cams, and must be reset for the next reversal. A further result is to throw out the set of pawls G_1 and to allow the idle set G_2 to come into action, thereby reversing the direction of rotation of the combination and starting another setting.

As soon as the travel of carriage M is completed (1½ revolution of the worm), the worm is constrained to act along the threads on L (1 revolution of the worm), until the feathers (shown in full black) over-ride the spring balls in shaft A. Immediately the clutch is thrown out of mesh on the left and into mesh on the right, thereby reversing the shaft. Just as the worm starts to jump, the cam on gear D engages one of the rollers N on L and throws the levers all down and the threads on L out of the worm.

With regard to the stopping of the mechanism after a predetermined number of reversals, the carriage M may be interrupted midway of its travel; the worm will then act upon L and withdraw the clutch until it is out of engagement on the left and cannot engage on the right. This is done by the pin O dropping into a groove in M, which it can only do when the four ratchets P (of 10 teeth) are properly aligned as regards the deep notch in each. The ratchets are operated consecutively by a four-fingered pawl on R, through the medium of a pin connection with M. The mechanism is encased and runs in oil.

* * *

Don't put even one pound more of metal into a piece of machinery than is absolutely necessary for practical purposes, because metal costs money, and you are working for the machine builder and not for the foundryman or the steel merchant.

GAS ENGINE DESIGN PROBLEMS*

By T. W. HOLLOWAY†

The following list of questions and answers relating to gas-engine and producer design may be of interest to some of the readers, for they are such as are constantly cropping up, having been collected from time to time by the writer in his daily work. The formulas and proportions presented have been found to give good results in practice.

Question 1.—When fitting the piston in the cylinder of a gas engine, how much smaller in diameter is it customary to make the piston than the diameter of the cylinder in order to give a proper working fit when hot?

Answer.—The diameter of a cast-iron piston may be made the same as the cylinder diameter less the sum of 0.0005 times the diameter of the cylinder bore and 0.005 inch. Therefore, a 10-inch cylinder would have a piston $10 - (0.0005 \times 10 + 0.005) = 10 - 0.01 = 9.99$ inches diameter. The diameter of a steel piston may be made equal to the diameter of the cylinder bore less the sum of 0.00075 times the diameter of the cylinder bore and 0.0075 inch, which is a little greater allowance than for cast-iron pistons. Therefore, if a steel piston is made for a 10-inch cylinder, the piston will be made $10 - (0.00075 \times 10 + 0.0075) = 10 - 0.015 = 9.985$ inches diameter.

Pistons for gas engines are sometimes made slightly smaller at the end next to the explosion than they are at the crank end in order to obtain a good working fit when the piston is hot; the end next to the explosion becomes hotter than the other end and, consequently, expands more. One reliable company makes the piston 0.997 times the cylinder diameter at the end next to the explosion, and 0.999 times the cylinder diameter at the other end.

Question 2.—What are some good formulas for proportioning both round and rectangular connecting-rods for stationary gas engines?

Answer.—When round connecting-rods are used on gas engines, they are usually turned with a straight taper from one end to the other. The amount of taper varies with different makers, but in the best practice it is about 0.08 to 0.09 inch per foot of length. Round connecting-rods are sometimes proportioned so that the diameter of the piston end is as small as 0.9 times the diameter at the middle, and the diameter at the crank end is as large as 1.1 times the middle diameter.

The diameter of a round connecting-rod at the middle may be found by the formula

$$D = F \sqrt[4]{PL}$$

in which

D = diameter at the middle section of the rod, in inches;
F = a factor varying from about 0.03 to 0.033 for ordinary stationary engines;
P = the maximum load on the piston in pounds per square inch;
L = length of connecting-rod in inches, the measurements being taken from the center of the piston-pin to the center of the crank-pin.

The diameter at the piston end should be checked by calculating the diameter of the neck of the rod for simple compression; a safe stress of about 8000 pounds per square inch should be used in making this calculation.

Most designers prefer to check these results, usually employing some column formula. A good formula for checking up a connecting-rod of either round or rectangular cross-section is

$$W = \frac{\pi^2 EI}{L^2}$$

in which

W = load on rod in pounds;
E = modulus of elasticity taken as 30,000,000 for steel;
I = least moment of inertia of section of rod;
L = length of connecting-rod in inches.

* For additional information on this subject, see the following articles published in MACHINERY: "Suggestions in the Design of Combustion Engines," "Crankshafts for Internal Combustion Engines," "The Crank-case Problem," and "Commercial Ratings of Internal Combustion Engines," April, 1910; "To Determine Size of Gas and Oil Engine Cylinders," February, 1909; and "Formulas and Constants for Combustion Engine Design," February and October, 1906. See also MACHINERY's Reference Book No. 65, "Formulas and Constants for Gas Engine Design."

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The factor of safety for a gas-engine connecting-rod should not be less than 9, and it generally ranges from 9 to 15. By dividing the load W, as found by the check formula, by the maximum load P on the piston, the factor of safety may be found. As an example, if the maximum explosion pressure in an 18 by 24-inch gas engine is 350 pounds per square inch, and the length of the rod is 2½ times the length of the stroke, what will be: (*a*) the diameter of the middle section of the rod; and (*b*) the diameter of the connecting-rod at the piston end?

(*a*) The total pressure P on the piston due to the explosion is $350 \times 0.7854 \times 18^2 = 89{,}064.36$ pounds. The length L of the rod is $2\frac{1}{2} \times 24 = 60$ inches. Taking F as 0.03, the diameter of the rod at the middle is

$$D = 0.03 \sqrt[4]{89{,}064.36 \times 60^2} = 4 \text{ inches}$$

The least moment of inertia I of a cylindrical section, as found from a table of moments of inertia, is $\frac{\pi D^4}{64}$, and for a 4-inch rod is therefore $\frac{3.1416 \times 4^4}{64} = 12.5664$. Using the check formula

$$W = \frac{10 \times 30{,}000{,}000 \times 12.5664}{60^2} = 1{,}047{,}200 \text{ pounds}$$

which gives the approximate factor of safety

$$\frac{W}{P} = \frac{1{,}047{,}200}{89{,}064.36} = 11.7$$

The calculation for the rod may be considered as satisfactory, as this factor of safety is well beyond the limit.

(*b*) In finding the diameter of the rod at the neck, use a taper of say 0.09 inch per foot. The taper from the middle will then be $\frac{60}{2 \times 12} \times 0.09 = 0.225$ inch. The diameter at the neck is $4 - 0.225 = 3.775$ inches. Checking by simple compression, the diameter of the rod at the neck should not be less than $89{,}064.36 \div 8000 = 11.133$ square inches. The diameter corresponding to this area is 3¾ inches. Therefore, the diameter of the neck found above is safe. The diameter may be taken as 3¾ inches. This will require a diameter of 4¼ inches at the crank end. The rod, therefore, has the following diameters: 4¼ inches at the crank end; 4 inches at the middle; and 3¾ inches at the neck.

Rectangular connecting-rods are much used on gas engines, especially on the better class of engines running at the higher speeds; the long side of the rectangle is always used in the plane of the motion. Considering the middle section of the rod, let X represent the breadth or shorter dimension of the rectangle and Y, the depth or longer dimension of the rectangle. The ratio of X to Y, which may be represented by K, varies in the best practice from 2 to 2½. After deciding on a value for K, the breadth or shorter dimension of the rectangular section of the rod may be found by the formula

$$X = F \sqrt[4]{\frac{PL^2}{K}}$$

in which X = breadth of rectangular section of rod in inches;
F = a factor varying from about 0.024 to 0.03 for ordinary stationary engines;
P = maximum pressure on the piston, in pounds per square inch;
L = length of rod, in inches, measured from center of piston-pin to center of crank-pin;
K = ratio of longer to shorter side of rectangular section of rod, varying from 2 to 2½.

The width or breadth of a rod of rectangular section is usually the same throughout the length of the rod, but the depth of the rod at the piston end is usually made less than it is at the crank end. The piston end may be made about 0.8 times the depth at the middle section, and the depth at the crank end may be made 1.2 times the depth at the middle section. The piston-end section should be checked by figuring for simple compression as in the case of the round rod. As an example, if the connecting-rod for the 18 by 24-inch gas engine mentioned above, is to be of rectangular section, (*a*), what are the dimensions at the middle and (*b*), what is the depth of the rod at the neck?

(*a*) Assume that the depth at the middle section of the rod is 2½ times the breadth; that is, the ratio of the longer to the shorter side of the rectangle is 2½. Taking a factor of, say, 0.025 for F, the breadth or shorter dimension may be found as follows:

$$X = 0.025 \sqrt[4]{\frac{89{,}064.36 \times 60^2}{2.5}} = 2\tfrac{5}{8} \text{ inches}$$

Since the ratio of depth to breadth is 2½, the depth of the rod is 2 1/2 × 2 5/8 = 6 9/16 inches. The moment of inertia for the rectangular section, found from a table of moments of inertia, considering failure to occur in the weakest direction, is $\frac{YX^3}{12.}$. The moment of inertia for the above section is $\frac{6\ 9/16 \times (2\ 5/8)^3}{12} = 9.9$. Applying the column formula for checking

$$W = \frac{10 \times 30{,}000{,}000 \times 9.9}{60^2} = 825{,}000 \text{ pounds.}$$

The total maximum load on the piston being 89,064.36 pounds, the approximate factor of safety is

$$\frac{825{,}000}{89{,}064.36} = 9.26.$$

This value is above the lower limit for the factor of safety, but if it is desirable to have a greater margin, the factor F may be increased slightly, or the ratio of the depth to the width of the rod may be lessened, thus giving the rod greater stiffness in the direction of its width, which is the weaker direction when treated as a column.

(*b*) The depth of the rod at the piston end may be made 0.8 times the depth at the middle; that is, 0.8 × 6 9/16 = 5 1/4 inches. The area of the rod at the small end will then be 5¼ × 2⅝ = 13.7 square inches. Checking for simple compression, the area at the small end should not be less than $89{,}064.36 \div 8000 = 11.133$ square inches. Since this is less than the area found above, the dimension may be considered safe.

Question 3—In the case of suction producers, how is the size of the gas pipe leading from the producer to the scrubber, and from the scrubber to the engine, determined?

Answer—There does not seem to be any definite rule giving the size of the gas pipe for a suction producer, but practical experience has shown that in order to have the cross-sectional area of the pipe large enough to eliminate excessive resistance, the velocity of the gas in the pipe should not exceed about 30 feet per second. A rule-of-thumb method which has given good results in practice is to use a 3-inch pipe for producers of 10 horsepower or less, and to add ¾ inch for each additional 25 horsepower. For example, a 60-horsepower producer would have a gas pipe $3 + (\frac{3}{4} \times 2) = 4\frac{1}{2}$ inches in diameter.

Question 4—Is it good practice to use a receiver in the gas pipe, and, if so, where should it be placed and what should be its volume?

Answer—In the best practice, a receiver, or expansion box, is placed near the engine in the gas main so as to furnish a good volume of gas from which to fill the engine cylinder. The volume of the receiver will depend somewhat on the space available, but in no case should it be less than one-half the volume of the cylinder, and it should preferably be larger.

Question 5—How much smaller should the journals of a gas-engine shaft be made than the diameter of the bearings, in order to have a good running fit?

Answer—The allowance for a running fit will depend on the diameter of the shaft. Under ordinary conditions the diameter of the journal may be made 0.001 inch smaller than the diameter of the bearing for all sizes of shafts up to 5 inches in diameter; 0.002 inch smaller for shafts from 5 to 12 inches in diameter; 0.003 inch smaller for shafts from 12 to 18 inches in diameter; and 0.004 inch smaller for all larger sizes.

* * *

There is no simple thing that will do more to take the gloomy haze off Monday morning than for every man about the shop to don clean overalls and jumpers.

THE EXTRUSION PROCESS*

METHODS, MACHINES AND ALLOYS

By E. F. LAKE†

The extrusion process for manufacturing metal shapes for various purposes is rapidly growing in favor. With it, intricate shapes can be made that would be impossible to roll and that would be very expensive to machine; and shapes that could be rolled can be produced more accurately to size by the extrusion process than by rolling, and they can be made from various kinds of metals. While the principle on which this process operates is a very old one, it was not a commercial success until the hydraulic press was enough developed to

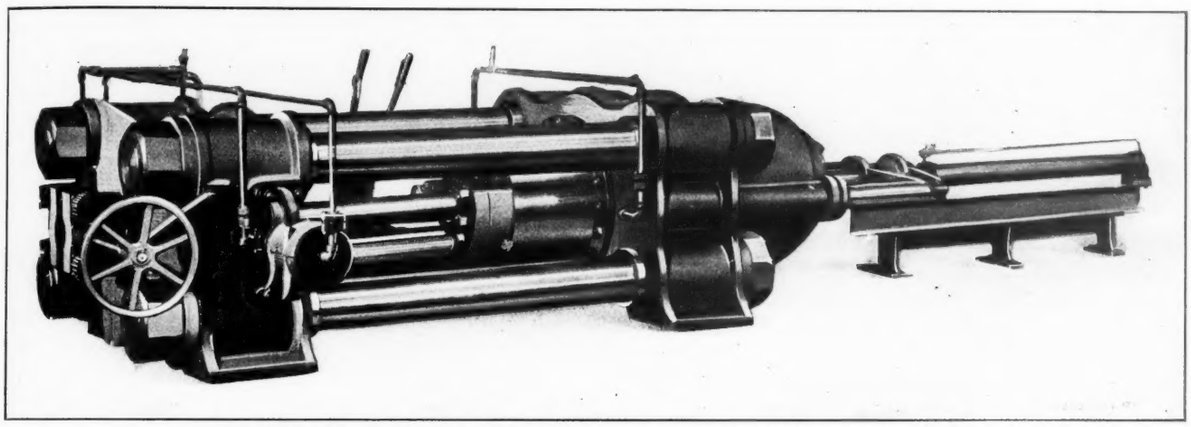


Fig. 1. Two-thousand-ton Hydraulic Extrusion Press, built by Watson-Stillman Co., New York

be used for this purpose. During the past two decades many improvements have been made that have enabled shapes to be made quicker and cheaper, and of metals that are stronger, harder and tougher than those formerly used. The great progress in metallurgy also has produced strong alloys that could be more easily extruded.

In Fig. 1 is shown one of the latest types of machines used for extruding or squirting solid metal alloys through metal dies into the required shapes. Like most other machines of the present day, the one shown has evolved, or gradually grown, from a crude, simple device. It has required the services of many engineers and mechanics and over a century of time, to develop it to its present state. The alloys and the methods of extruding them have also passed through the same evolution. Notwithstanding this, some manufacturers very zealously guard the methods employed in producing extruded shapes as secret processes. Like many other methods, however, they are secret in name only, and the details can always be obtained by those who make a study of this subject.

Historical Review

The first patents on record were taken out in England in 1797. Like the die-casting process, the extrusion process started by using lead for the metal to be extruded. Lead-tin alloys were used later, and these developed into the lead-tin-antimony compositions that are used for type and anti-friction metals, and led the way to the copper-zinc alloys that may contain small percentages of aluminum, lead, nickel, iron or other ingredients.

One of the first forms of extrusion machines is shown in Fig. 5. In this the cylinder was packed full of lead and the whole heated so that the hand screw would squirt the lead out at the end in the form of a lead rod of the shape or size desired. The lead-tin alloys used for soldering were made into rods in a similar manner. The next step was to put a rod in the center of the plunger as shown in Fig. 6. This rod partly filled the opening through which the metal passed, so that the latter was extruded in the shape of a tube. This simple tool was enlarged and developed into a power-driven machine, and used in the manufacture of lead pipe. The machine, still further enlarged, was used for making very large lead pipe, which, after it left the machine, was split longitudinally and straightened out into lead sheets.

Later, special machines were designed for making lead sheets in a different manner. In 1847, J. Robertson designed the machine shown in Fig. 7. In this, the opening at *A* was filled with lead and plunger *B* was forced down into it, causing the lead to rise on both sides in thin sheets as shown at *C*. This machine was improved by making plunger *B* entirely fill opening *A* and cutting a slot at *D* to allow the lead sheet to come out at the bottom. Still later, the machine was made horizontal and dies inserted at *D*, so that the sheets could be more easily handled and sheets of different thicknesses made by inserting different dies.

In 1863 tin-lined pipe was made by placing a hollow ingot of tin inside of a hollow lead ingot and forcing both through the die as shown in Fig. 2. In this, *A* is the hollow lead ingot; *C*, the hollow tin ingot; *B*, the die; and *D*, the ram that forces the metal through the die. Previous to this, lead pipe was lined with tin by melting it inside of the pipe, but it was very difficult to make the tin cover the whole interior of the pipe, and it would be likely to form lumps and be unequal in thickness. While the new method overcame this trouble, it presented other difficulties due to the sharp corners in the cylinder. Therefore, the lead ingots were cast in a mold of the shape shown in Fig. 3, and the tin ingots were cast in another mold that would make them fit the inside of the lead ingot. Another difficulty encountered was due to the uneven heating of the dies, and they were jacketed as shown in Fig.

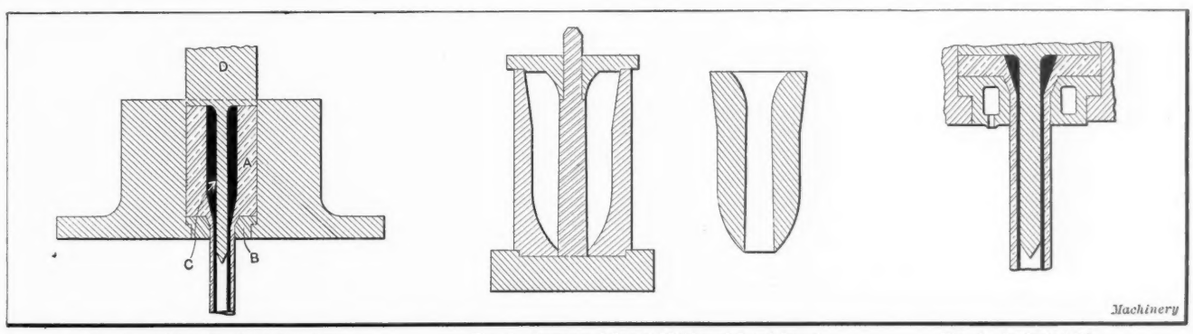


Fig. 2. Making Tin-lined Lead Pipe Fig. 3. Improved Ingot Mold and Lead Ingot Fig. 4. Jacketed Die

* See MACHINERY, August, 1906: "Extruded Metal Sections."
† Consulting Metallurgist, 184 Ave. B, corner 47th St., Bayonne, N. J.

4, so that steam or water could be circulated through them. In this way the die could be heated up to the required temperature before starting to make pipe, and maintained at this temperature while running.

In 1869, A. H. Hamon of Paris, France, patented the hydraulic press shown in Fig. 8 for manufacturing tin-lined lead pipe. In this the lead ingot that surrounded the hollow tin ingot was placed in the cylinder at *A*, and ram *D* was operated to force the metal through the die at *C* and the opening at *B*, where it was coiled onto a reel. A blast of hot air or

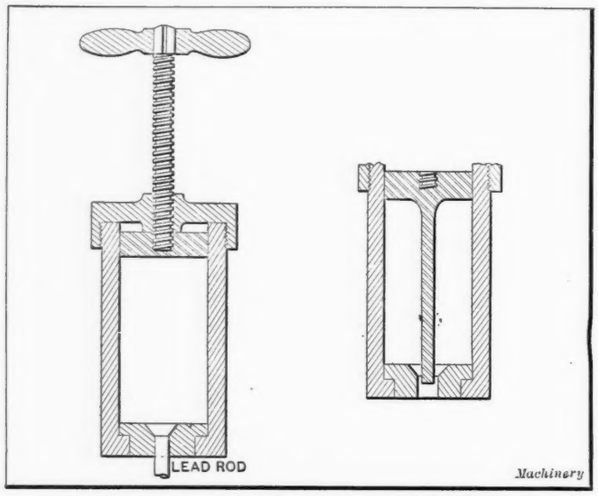


Fig. 5. Early Press for Making Lead Rods

Fig. 6. Principle of Press for Making Lead Pipe

steam was sent through the ports *E* to bring the metal to the correct temperature for extrusion. This temperature was below the melting point of the tin, but high enough to make the mass pasty, so that it could easily be extruded through the die. This design is practically the same as that of the extrusion machines of the present day. Some details have been improved, however, and metals of a higher melting tem-

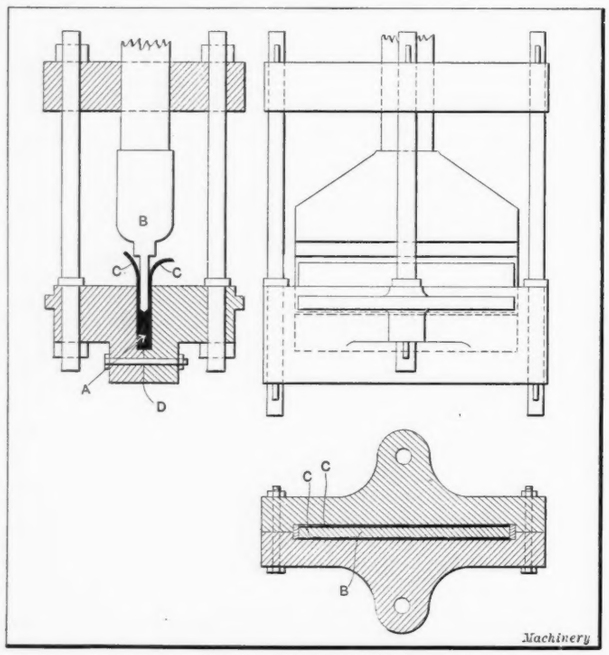


Fig. 7. Machine for Making Lead Sheets

perature can be extruded. Thus, some of the more plastic brasses are now made into commercial shapes.

In 1873, Robert Cunningham patented a device for making curved pipe for water traps, and a re-issue of this patent was granted in 1881. This device is shown in Fig. 9. It can be attached to any machine that contains hot lead and the required mechanism for squirting the lead through it. The diaphragm *A* moves back and forth through case *B*. Its center hole will thus, at times, be eccentric with the interior opening of the case, and, thereby, control the volume of metal that passes through this opening on different sides. When the hole in the diaphragm is central with the case, the volume of metal that passes through on all sides of core *C* will be equal, and the extruded pipe will be straight, as shown in the upper right-hand corner of the illustration. When the diaphragm is moved to the left, however, the largest volume of metal will pass on the left-hand side of core *C*, and the pipe will curve to the right, as shown in the lower left-hand view. When diaphragm *A* is pushed to the right, the volume of metal will be largest on the right-hand side, and the pipe will curve in

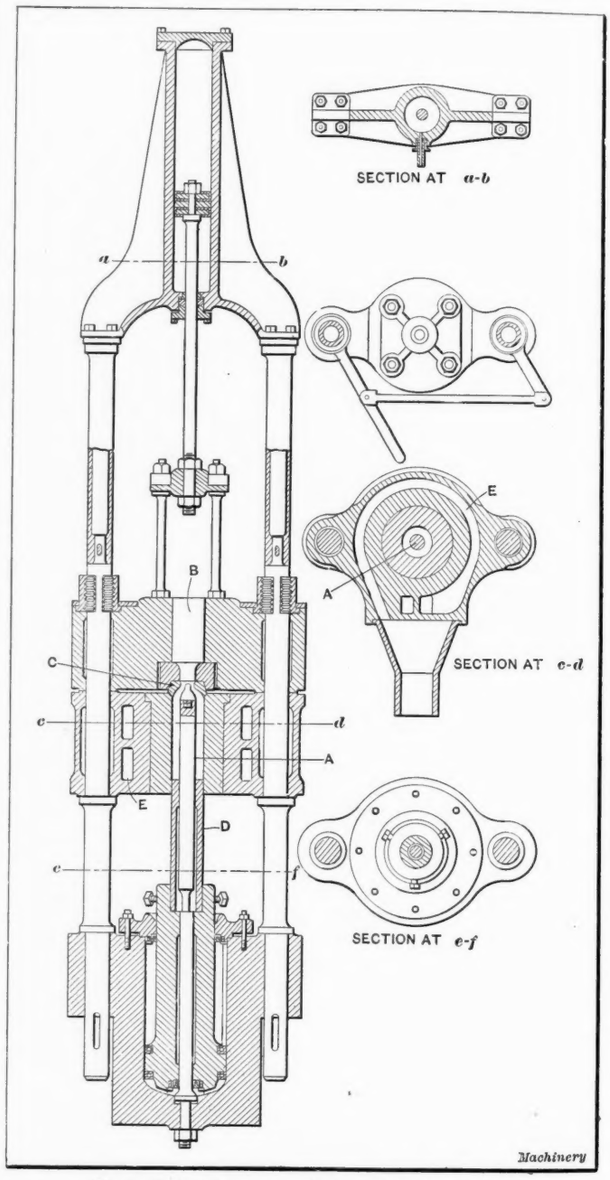


Fig 8. Hydraulic Press for Making Tin-lined Lead Pipe

the opposite direction. Thus, by pushing this diaphragm to the right and left the required distance, traps can be made as shown in the lower right-hand view, and these can be given any desired form.

Another method of accomplishing the same results is shown in Fig. 10. In this case the volume of metal on different sides of the core is controlled by two rams. When rams *A* and *B* are forced in at an equal speed, the metal coming out around core *C* will be equal in volume on all sides and the pipe will be straight. If ram *A* is made to travel faster than ram *B*, the volume of metal to the right of core *C* will be the greater, and the pipe will curve to the left. If ram *B* is made to travel faster than *A*, the volume of metal to the left of core *C* will

be the greater, and the pipe will curve in the opposite direction.

In Fig. 11 is shown still another device that performs the same work. In this case ram *A* is made in two halves, each of which can be driven at a different speed. Hence, the metal on either side of partition *B* can be forced through the opening around core *C* in varying volumes. This causes the lead pipe to curve in either direction as much as desired, or extrudes it in a straight line.

The softer metals were also extruded in other shapes for various purposes, such as printers' leads, shapes for holding

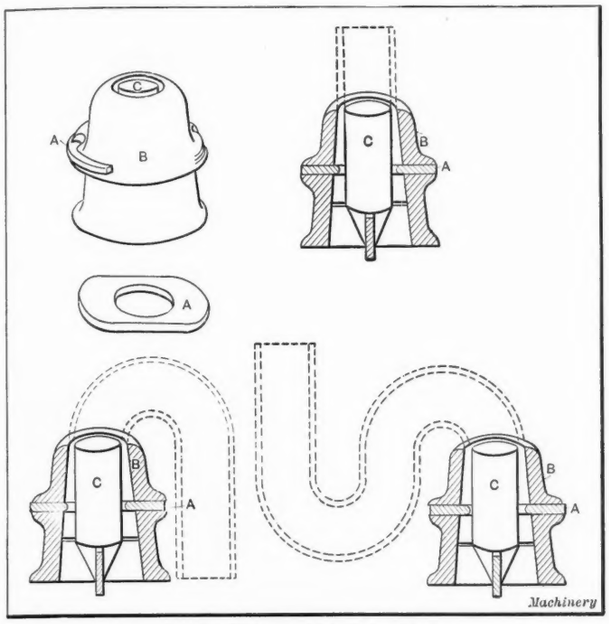
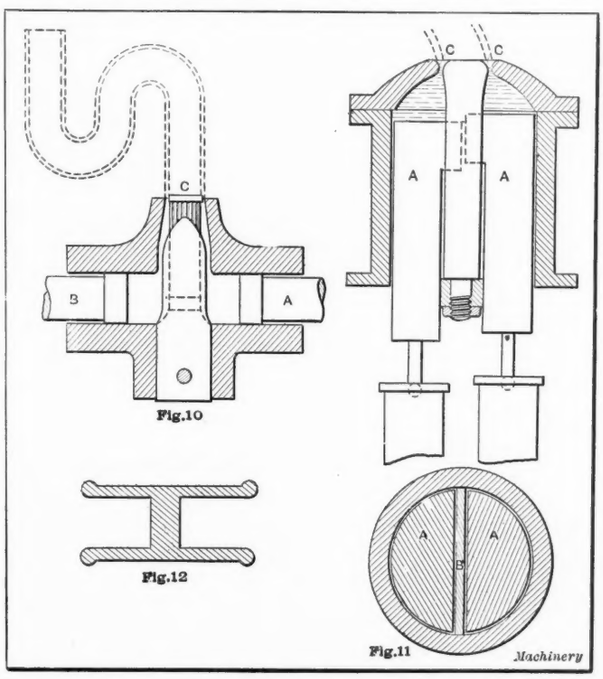


Fig. 9. Device for Making Lead Traps

glass in leaded glass windows (as shown in Fig. 12), etc. Very thin metals used for metal foil were also produced. These latter were made from lead-tin alloys, and many different compositions were used to get stronger, tougher and better



Figs. 10 and 11. Other Devices for Making Curved Pipe. Fig. 12. Extruded Shape used for Leaded Glass Windows

wearing metals than pure lead. Very thin tubes, such as are used for artists' paints and similar materials, were also made by a similar process. At *A* in Fig. 13 is shown a disk of metal with plunger *B* in position to be forced down into it. At *C*, the plunger is shown at the bottom of its stroke and the tube is completely formed. The grids or plates for secondary batteries were made by the extrusion process as much as twenty-five years ago. These consist of narrow strips of metal crossing each other, and joined at the intersections so as to form hollow squares. They often have more than one hun-

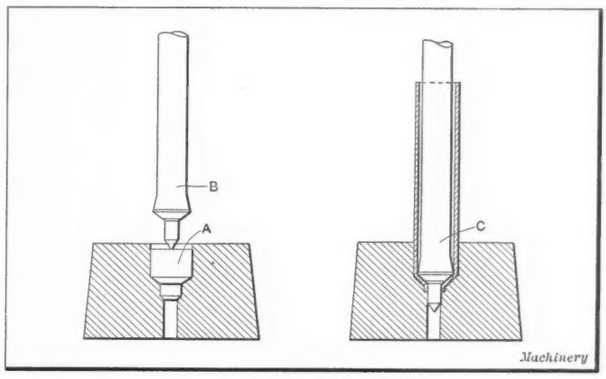


Fig. 13. Method of Tube Making

dred squares in them. They were made by extruding a long cellular mass which was later cut up into thin grids.

When metals or alloys with a higher melting temperature than the lead and tin first used were formed into various shapes by the extrusion process, several problems other than that of a powerful machine presented themselves. One of the greatest of these problems was that of the temperature. It was very desirable to be able to extrude brasses and bronzes, as they were much stronger than alloys with a lead or tin base. It was necessary to keep the temperature below the fusion point, as otherwise it would be difficult to cool the extruded shape to the solid state before it left the die. Also, if the metal was too soft when being extruded, it would not be subjected to the compression required to give it the additional strength that made the process really valuable. On

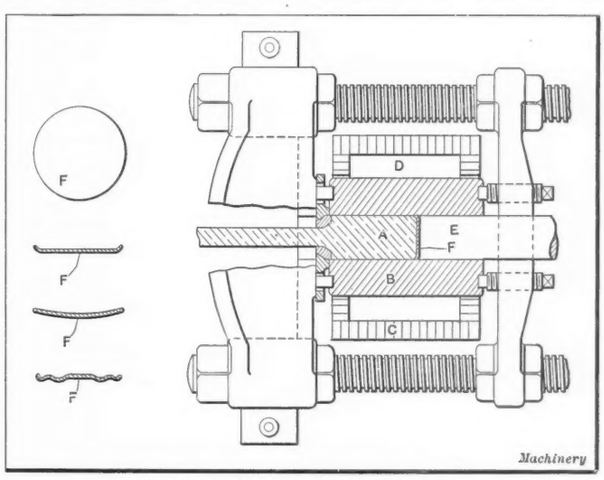


Fig. 14. Coke-fired Ingot Container

the other hand, if the temperature was not high enough, the metal would not extrude through the die opening, and the billet would spread in the cylinder or container, grip the side walls, and thus become wedged in.

It was also difficult to find a metal for the dies that would withstand the strains produced by the hydraulic ram, or keep cool enough when the heated metal was being forced through. It was found, however, that tungsten steel would not soften enough to be pressed out of shape when brasses and bronze were extruded at a temperature just below the melting point. To maintain this temperature while the whole billet was being extruded was, however, difficult. This difficulty was finally overcome by designing special billet containers, and these are now a part of all extruding machines.

Billet Containers

One of the first designs of this type was patented by George A. Dick in England in 1893. This device is shown in Fig. 14,

in which *A* is the billet of metal that is being extruded; *B*, the cylinder or billet container; *C*, a case built around the container; and *D*, a passage through which the flames from a coke or coal fire were passed. With this apparatus, copper and zinc alloys that were red hot and plastic at from 800 to 900 degrees F., were successfully extruded. When the billet was inserted in the container, a disk similar to those shown at *F* was placed over the end of the ram *E*. This disk will spread, fit the wall of the container tightly, and prevent the

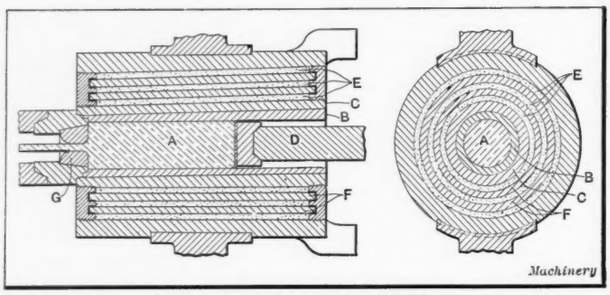


Fig. 15. Steel and Asbestos Container

metal in the billet from squeezing back past the ram and wedging it. These disks were made from metal with a higher melting temperature and less plasticity than the metal being extruded.

While this device worked better than anything previously used, it was difficult to control the coke fire so as to maintain a uniform temperature. Another difficulty was met with in trying to conduct the heat away from the head, owing to the thickness of the metal that had to be used to withstand the pressure exerted by the hydraulic ram. As considerable heat was given out by the billet, and the penetration through the thick cylinder wall was slow, the exterior would be much cooler than the interior. This caused unequal expansion and

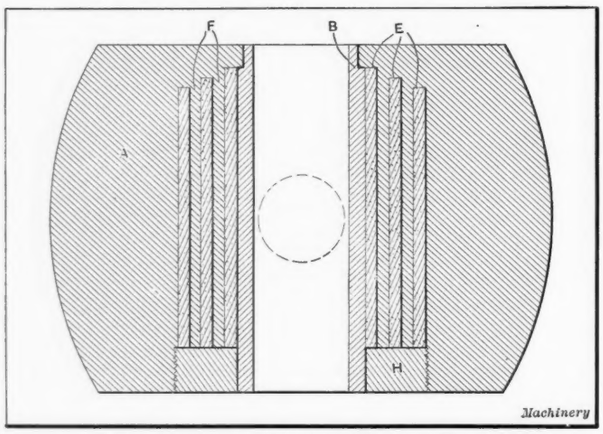


Fig. 16. Cast Container with Layers of Heat Insulating Materials

contraction, and frequently resulted in cracks and fractures. Hence, a built-up head or billet container was designed, having alternate layers of steel and asbestos.

One of the first built-up containers is illustrated in Fig. 15. This also was designed by Mr. Dick in the same year as the coke-fired container. Most of those in use at the present time are built on this principle; *A* is the billet; *B*, the tapered container that fits into a tapered hole in the built-up cylinder; *D*, the ram; *E*, the openings between the steel rings *F*, which are packed full of asbestos; and *G*, the die through which the billet is extruded.

By surrounding the walls with several layers of refractory material, like asbestos, supported by steel rings, the heat was prevented from penetrating the cylinder walls. By thus keeping the cylinder at a lower temperature, it had greater power to resist the pressure from the ram; and by retaining the heat in the billet, its temperature was kept more uniform, and it could be more easily extruded. This design also greatly reduced the unequal expansion and contraction and the consequent cracking and breaking. These cylinders, or containers, enabled the extrusion process of manufacturing metal shapes to become much more of a commercial success, and to-day many parts are being manufactured more economically in this manner than they formerly were by casting in sand molds.

Following the Dick designs, many forms of billet containers have been designed. Fig. 16 shows one in which the outer case *A* and steel rings *F* were cast in one piece. After the billet container *B* had been put into position, the openings were packed with heat-insulating materials, and ring *H* was screwed into the case. In Fig. 17 cores were made from broken granite, soapstone, trap-rock or other suitable heat insulating materials, and these were located in the mold and the case cast solidly around them. Billet container *B*, however, was inserted as a separate piece, because this part wears and must be replaced, while the container proper may last indefinitely. It is not always possible to manufacture cylinders in this way, as the metal from which they are cast may shrink much more than the refractory material in the cores. This is almost sure to cause a fracture in the casting when

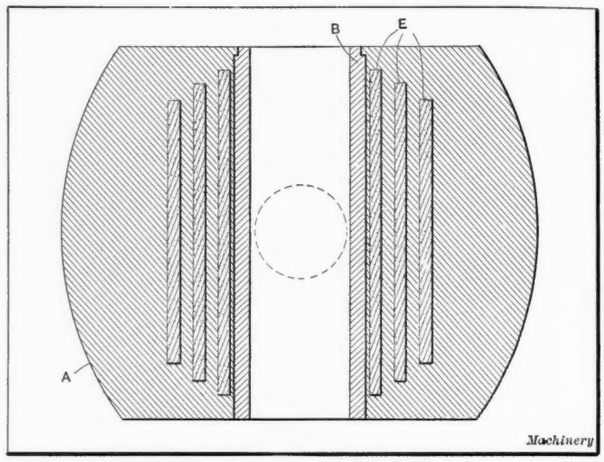


Fig. 17. Another Type of Cast Container

it is solidifying. A style in which the cylinder is cast hollow is shown in Fig. 18. After the billet container *B* has been placed in position, the hollow space is filled with refractory materials like glass, sand, etc., by forcing these materials through valve *I*, with a force pump, as shown.

In Fig. 19 lining *B* is wound with asbestos-covered flat wire and the cylinder clamped together over this with bolts. The

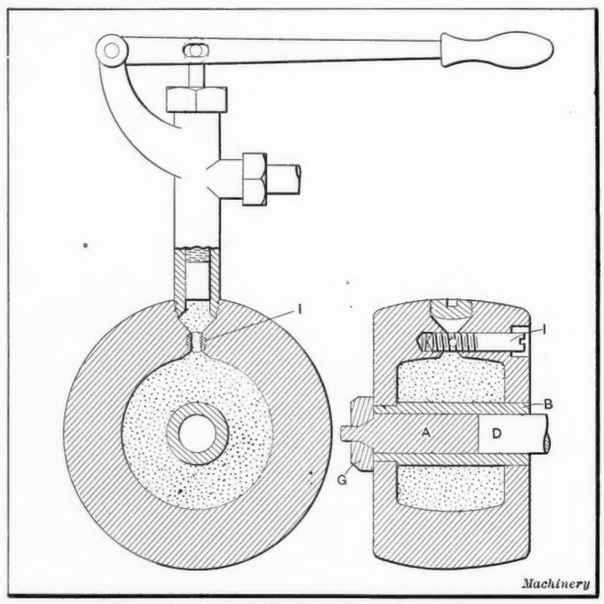


Fig. 18. Heat Insulation forced into Place by Pump

form of wire shown at *J* is used, and the coils are separated by rings of asbestos. This retains the heat and strengthens lining *B* enough to prevent it from bulging or cracking under the pressure transmitted by the ram. The rings of asbestos

may be left out, and the covered wire wound in solid, or it may be wound alternately with strips of asbestos of the same size, staggered. A sectional view would then present the appearance of a checker board.

Electrically-heated Container

One of the latest types of cylinders is arranged so that the ingot to be extruded can be electrically heated. Not only the cylinder, but the die block and the end of the ram also can be similarly heated. This is shown in Fig. 20. Here *A* is the

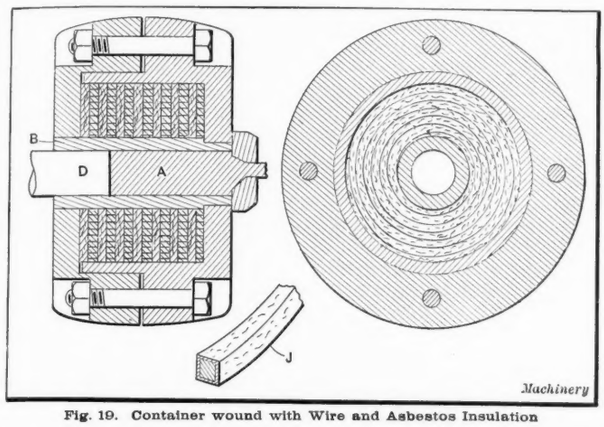


Fig. 19. Container wound with Wire and Asbestos Insulation

ingot that is being extruded; *B*, the billet container; *C*, the cylinder; *D*, the ram or plunger; and *E*, the winding of metallic tape which has enough resistance to impede the current and generate the heat. A section of this tape is shown at *X*. It is usually made of copper and covered with some insulating material. Insulating material that confines the electric current and prevents it from entering other parts of the machine is shown at *F*; *G* is the die, and *H* the die block, which may also be electrically heated by constructing it as shown at *Y*. The end of the ram *D* may be electrically heated by constructing it as shown at *Z*. This would entirely surround the billet with electric heating apparatus.

In extruding machines or processes, the billet is heated to the proper temperature before it is placed in the cylinder, and hence the only thing required is a maintenance of this temperature until the metal has been extruded. If, therefore, the cylinder were electrically heated, it might be all that would be required. The ram would seldom require heating, and it would weaken it to place a resistance in the end of the ram. For metals with higher melting temperatures, however, it might be desirable to heat the die-block electrically, and this could readily be done as shown. The electric current is by far the best means of heating the metal and maintaining it at a steady temperature. With rheostats, the current can be easily controlled, and, consequently, the amount of heat required to maintain an alloy at a certain temperature is easily regulated to within a few degrees.

Special Forms of Containers

An attempt was made to abolish the troubles caused by billets adhering to the container walls as shown by the design in Fig. 21. Here billet *A* is much smaller in diameter than container *B* and is surrounded with some kind of liquid at *C*. Thus, when ram *D* forces the metal through die *E*, liquid *C* is supposed to keep the ingot from gripping the walls of the container and wedging therein. It is claimed for this method that aluminum or metals of similar ductility can be extruded at atmospheric temperature, this being due to the fact that the billets can be made much smaller in diameter than the interior of the containers; that the ram *D* need only be a tight fit at the extreme end of the container; and that the liquid acts as a lubricant, and the adhesive force is thus entirely overcome. Thus a greater power can be applied to the ram, and the extruded metal be made more dense. The heat can also be done away with, except that which is caused by friction when the metal passes through die *E*. The liquid *C* can be oil when metals are extruded cold, and this will lubricate the apparatus and aid in overcoming the friction as it passes through the die. Water also might be used. Metals of a higher melting temperature could be extruded, and consequently greater strengths obtained. When it became necessary to heat metals for extrusion, fused caustic potash or other materials might be used.

In attempting to press cold metals through a contracted hole like the die of an extrusion press, the billet spreads under the compression and grips the side walls. To overcome this adhesive force and make it less than the forward pres-

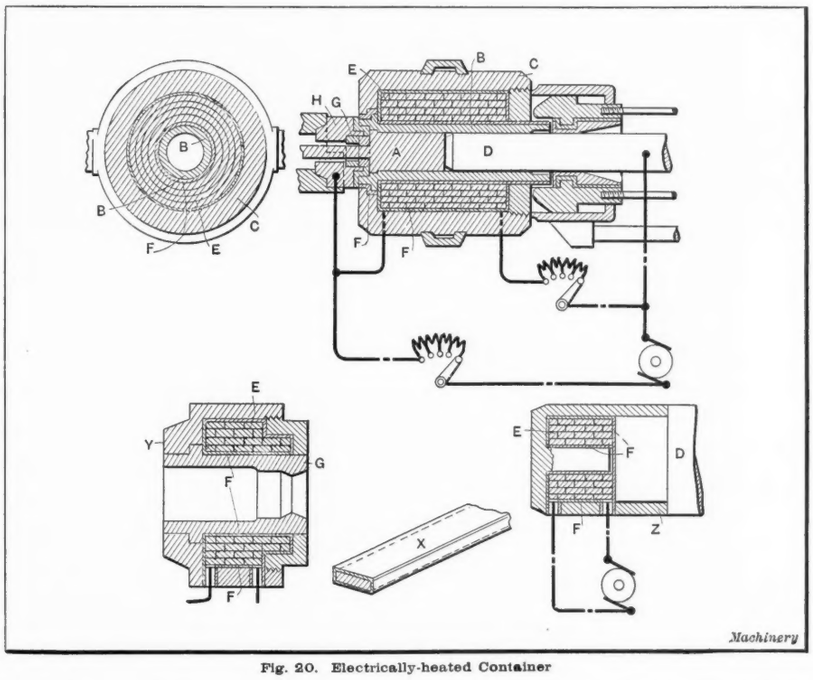


Fig. 20. Electrically-heated Container

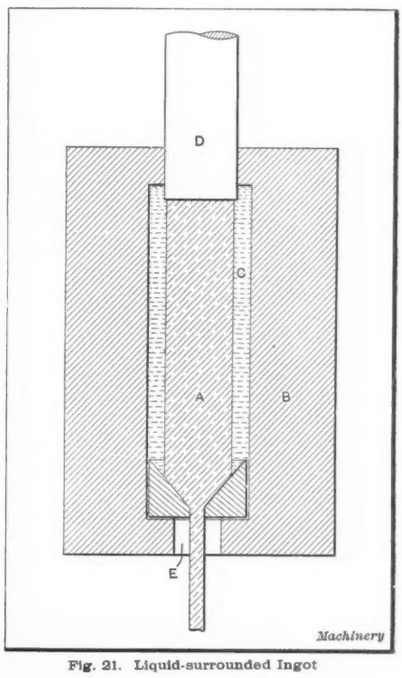


Fig. 21. Liquid-surrounded Ingot

sure of the ram, billets are softened and made plastic by raising their temperature. This also reduces the strain against the die. If the extruding metal is heated too high it will be too soft, and its grain will be coarsened. The design of cylinders requires that the ram or plunger shall fit the billet container so tight that no metal from the billet can force its way between the ram and the container wall. At the same time it must be loose enough not to score the sides of the container. These requirements also put a limit upon the pressure which can be employed. This limit is not very high, owing to the fact that the die spreads in proportion to the

strain put upon it. The higher the temperature to which it is heated, the more will it give way to this strain.

When metals are extruded at atmospheric temperature, a higher pressure must be used. The metal is condensed more and the grain greatly refined. This adds strength, hardness, and toughness to the metals to a degree that it is impossible to attain in other ways. One illustration of the pressures required is shown by the fact that to extrude aluminum at 600 degrees F. only requires one-fifth of the pressure that is required at 70 degrees.

A Modern Extrusion Press

The principal parts of a complete modern extrusion machine are shown in detail in Fig. 22. Nearly all of the hand labor is done away with in this machine: It heats the billets to the proper temperature, inserts them in the container by hydraulic pressure, and extrudes them by the same pressure. Four gas heated furnaces are located around a central shaft under the extruding press so that their tops come a little above the floor line. Three of the furnaces when they are in the positions *A*, *B* and *C* are covered with a disk screen *E*, that has an opening over each furnace. When starting the operations, the cold billet is inserted in the furnace located at *A;* cover *F*, containing a vent-hole, is placed over it, and the furnace revolved to the position at *B*. It is next revolved to the position at *C*, and while in the positions *B* and *C*, other billets are being extruded. After this, it is turned to the position at *D*.

The cylinder is then revolved on trunnions to the position shown at *G;* cover *H* is placed over it, and billet *I* is pushed up into it by hydraulic piston *J* raising loose block *K* from the bottom of the furnace where billet *I* rests on it. The gas for heating the furnaces enters the hollow shaft on which they revolve, and passes out through ports and piping to each of the four furnaces. The air passes through ports surrounding this hollow central shaft and then through pipes to the different furnaces. After the billet is in the cylinder, this is again revolved on its trunnions to the extruding position; projection *L*, on disk cover *E*, prevents the billet from falling out while the cylinder is being revolved.

With the extrusion cylinder in position, fluid is admitted under pressure to the hydraulic cylinder through port *M*. This moves the hollow piston *N* forward and first transmits power to the device *O* and rod *P* and causes part *Q* to butt against extrusion cylinder *G* and hold it firmly in its seat

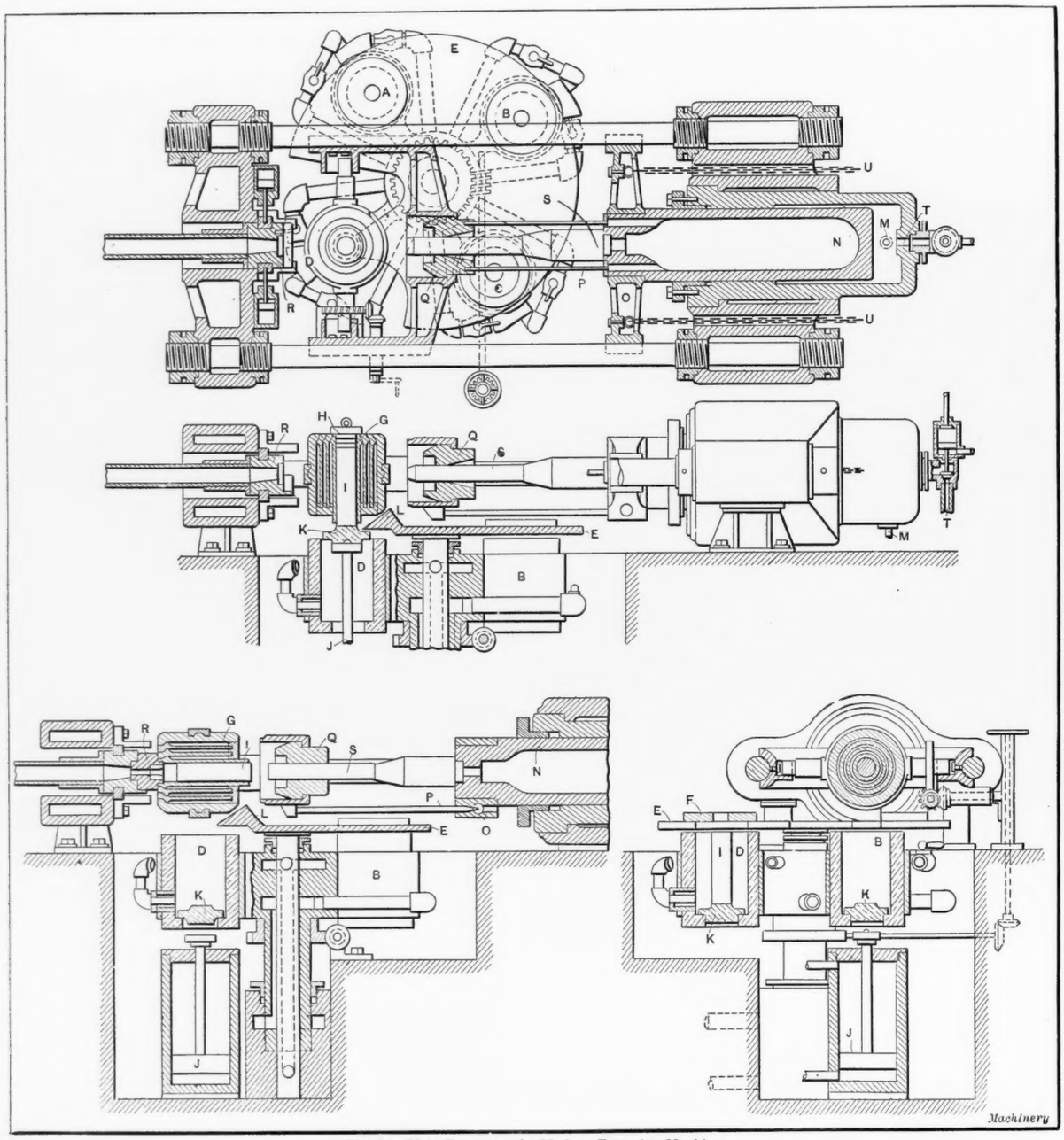


Fig. 22. Main Features of a Modern Extrusion Machine

against the die and die-holder *R*. Container cover *H* has, of course, been removed. Now, ram *S* acts on billet *I* and extrudes it through die *R*. When the ram has reached the end of its stroke, the fluid is allowed to escape through port *T* and with the other mechanism attached, the ram is brought back to the starting position by weights attached to chains *U*.

In this machine, as well as in others, a small end of the billet cannot be extruded. This part often sticks in the cylinder, but it is easily removed by turning the cylinder over the furnace at *D* and turning on the gas, so as to melt it out. With this machine many alloys can be extruded that could not be used with the cruder and simpler machines formerly employed.

Metals and Metal Alloys used in the Extrusion Process

In the extrusion of metals it is natural that lead should have been the one first used, as this is the most plastic of metals. Lead in the form of filings can be compressed into solid metal with 13 tons pressure to the square inch. It will flow through all the cracks of the apparatus, like liquid, when a pressure of 32 tons per square inch is applied to it. Its plasticity as compared with that of other metals is shown by the fact that powdered tin can be made into solid metal with a pressure of 19 tons per square inch; copper, with 33 tons; zinc, antimony, aluminum and bismuth with 38 tons, while other metals require considerably greater pressure than this. Tin would flow through the cracks of the apparatus like liquid at a pressure of 47 tons per square inch, and the other metals at a considerably higher pressure. Lead and tin, or any alloys that might be made from them, however, have very little strength and thus their use has been limited.

While copper is very malleable, ductile and tough, and consequently would flow freely through a die under pressure, it has but limited strength, and, consequently, cannot be used for very many purposes. As lead, bismuth or antimony have an injurious action on copper and make it hard, brittle and cold short, these elements cannot be alloyed with it for extrusion purposes, except in very small quantities. When more than 0.5 per cent lead is added to copper it makes it both hot and cold short, and it cannot be worked hot; 0.2 per cent lead, however, may be present without impairing the tenacity of copper. Tin in small quantities does not appear to affect the working properties of copper, except to make it somewhat harder. Larger percentages of tin, however, would render copper too hard for extrusion purposes, and would give it a flaky grain that weakens the metal. When zinc is alloyed with copper, 1 per cent zinc will make the copper hard and red short, but 20 per cent zinc alloyed with 80 per cent copper will produce an exceedingly malleable alloy. Small percentages of zinc do not alter the character of copper in other ways. The zinc also produces a greater tensile strength.

An alloy composed of 55 per cent copper and 45 per cent zinc was the first comparatively strong metal that was used for extrusion purposes. This is also one of the most common alloys used at the present time. The brasses that contain from 50 to 60 per cent copper and 40 to 50 per cent zinc are the most plastic, and hence are the alloys most frequently used for extruded metals. The brasses containing from 75 to 85 per cent copper are malleable while hot, but are rather too hard to extrude easily, while the brasses containing from 62 to 70 per cent copper are not malleable at a red heat and hence are difficult to extrude.

Small quantities of iron add strength to the brasses and do not make them difficult to extrude; hence Delta metal, manganese bronze and similar alloys can be used in the extrusion process. Aluminum, when used in small percentages, makes copper harder than when 8 to 10 per cent is used, and hence the aluminum bronzes with from 8 to 10 per cent of aluminum are the most easily extruded. An alloy containing 90 per cent copper and 10 per cent aluminum, or one with 85 per cent copper, 10 per cent zinc, and 5 per cent aluminum is used for the extrusion process, but ordinarily the copper content is kept lower than this. With these aluminum bronzes, however, a tensile strength of from 65,000 to 85,000 pounds per square inch is obtained, with an elastic limit of from 40,000 to 60,000 pounds, an elongation in 8 inches of about 18 per cent, and a reduction of area of about 20 per cent. Some tests on extruded shapes made for the Government have shown even better results than this.

Pure zinc can be greatly strengthened by an extrusion process conducted in the proper way. If the area of the die opening in relation to the area of the zinc billet to be extruded is in the ratio of 1 to 15, the temperature of the metal is kept between 85 and 180 degrees F., and the extruded metal is submitted to a pressure of not less than 90,000 pounds per

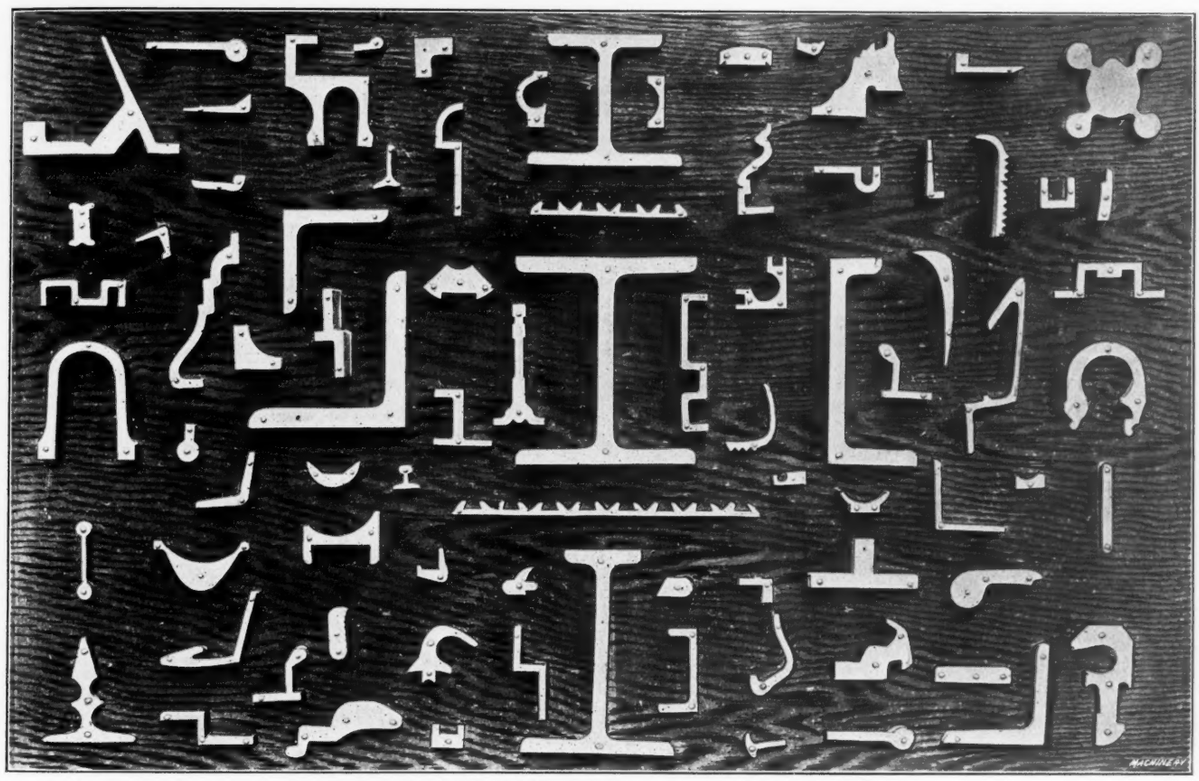


Fig. 23. Examples of Extruded Metal Shapes produced by the Coe Brass Mfg. Co.

square inch, the coarse crystalline structure of the ordinary zinc is transformed into a fine grain, and the zinc assumes the properties of brass. A tensile strength of 29,000 pounds per square inch can be obtained in this way and an elongation of from 26 to 70 per cent. For comparison, ordinary zinc only has a tensile strength of 5000 pounds per square inch and almost no percentage of elongation. Zinc in the extruded condition can also be readily worked with machine tools and it is quite malleable and flexible.

Examples of Work Produced by the Extrusion Process

In Figs. 23 and 24 some of the shapes that are manufactured by the extrusion process are shown. The half-tone illustration Fig. 23 shows sections made by the Coe Brass Mfg. Co., Ansonia, Conn., the well-known maker of extruded shapes. Various special forms of angles are made in this way. Gears, ratchet wheels, gear racks, padlock hasps, and other special shapes are turned out in long bars which are afterwards sawed up to give the pieces their required thickness. Moldings have also been made for the Navy Department. An extruded angle that was made for the Navy had a tensile strength of 85,000 pounds per square inch, an elastic limit of 33,800 pounds per square inch, an elongation in 8 inches of 18.1 per cent, and a reduction of area of 20 per cent. Some quite intricate shapes have been made.

Where parts, such as flat lock keys, can be made in the punch press, they can be made cheaper this way than by the

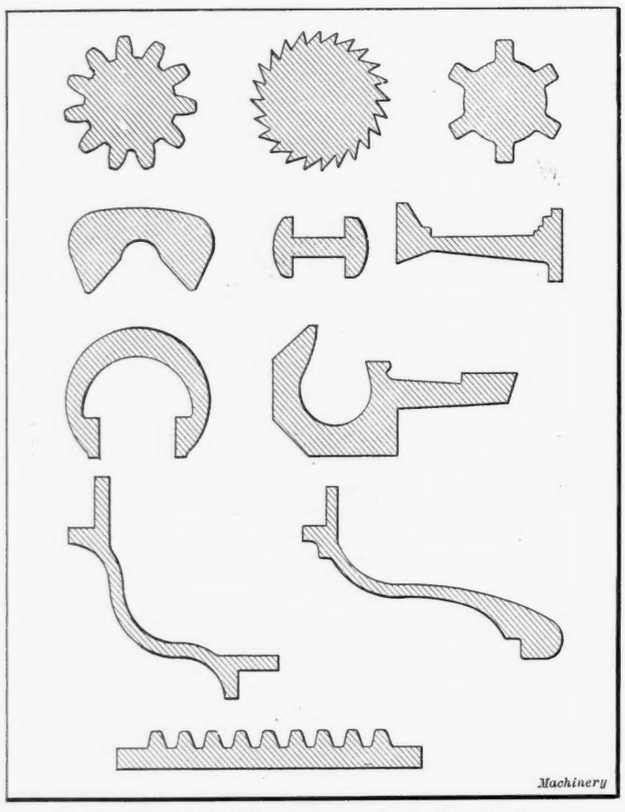


Fig. 24. A Collection of Shapes produced by the Extrusion Process

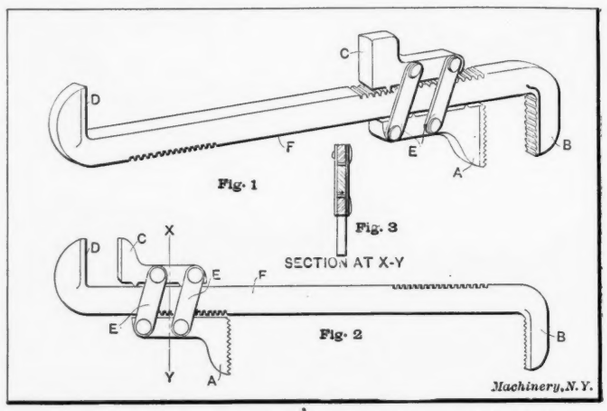
extrusion process. Such parts as the hasp on padocks, however, are made more economically by the extrusion process, as they would be difficult to punch out owing to their thickness. There are also numerous other lock parts that are cheaply made from extruded metal. The extruded shapes can be made to within 0.0005 inch of the correct size. This makes the process very useful for parts that would otherwise have to be machined.

[The foregoing review of the art of extruding metals shows its state as recorded in the patent office and gives an idea of its commercial importance and future. The extrusion process is of extraordinary interest to engineers because of the inherent mechanical difficulties and the larger possibilities that may be realized when metals or materials of greater strength and heat-resisting power have been discovered and more minds are working on the problems. It is said that the process saves about one cent a pound in the manufacture of certain brass or bronze shapes as compared with drawing. Readers who can contribute authoritative articles treating of the details of dies, hydraulic clamping devices, rate of production, etc., are requested to communicate with the editorial department.—EDITOR.]

* * *

COMBINED NUT AND PIPE WRENCH

The nut and pipe wrench shown in the accompanying illustration is the subject of patent No. 994,364 granted to George R. Blair, Bellevue, Pottawatomie, Kans. Fig. 1 is a perspective view of the device arranged as a pipe wrench, Fig. 2 shows the device arranged as a nut wrench, and Fig. 3 is a cross-section taken on the line *X-Y*. This wrench consists essentially of a shank with both ends bent in opposite directions at right angles to the shank, and two movable jaws, one on each side, connected by links. The jaw *A* and end *B* of the wrench are provided with teeth, this part of the device being used as a pipe wrench, while the jaw *C* and end *D* are plain, and are used as a nut wrench. The connecting-links *E* are fastened to the jaws *A* and *C* by rivets, as shown, but



Figs. 1 to 3. Side, Perspective and Sectional Views of Combined Nut and Pipe Wrench

they are not riveted tightly, so that the jaws may be moved to put the links in a position at right angles to the shank, this being necessary to move the jaws along the shank. Teeth forming a rack are cut in the shank *F*, on each end, in which two teeth formed on the jaws mesh when the wrench is in position for gripping the nut or pipe.

In using this device, either one movable jaw or the other, as desired, is moved along the shank to engage the work with the complemental fixed jaw. The opposite jaw is then pushed forward so as to cause the links *E* to assume an oblique position relative to the shank, the teeth on the jaws being engaged in the teeth in the rack. It will thus be seen that any tendency of the jaws to open will be effectively resisted by the canting effect, and the interlocking engagement of the two teeth of the jaw with those in the rack.

* * *

The Hungarian government has decided to take charge of the tremendous natural gas resources discovered at Kissarmas in Transylvania, of which the daily yield is said to amount to 26,000,000 cubic feet. This is the most important source of gas, so far discovered, in the world. This natural gas supply promises to become a source of wealth for the whole country, now that the government has decided to control the output. This is the true object and method of conservation—that the natural resources of a country are being used for the benefit of the whole people.

* * *

Ancient iron furnaces consisting of cavities or holes set with stone and having a hard burned bottom of clay mixed with slag, have recently been discovered in Hedesunda in Sweden. It is claimed that this kind of primitive furnace was used for the production of iron earlier in Sweden than in any other country. Those found at Hedesunda are the largest known; it is estimated that they were in use more than two thousand years ago.

CHAIN HARDENING BY THE TON

By CHESTER L. LUCAS*

To harden three tons of steel chain per day, and perform this feat day after day, sounds like a stupendous job of hardening for four laborers, especially when it is added that the time spent in actual hardening is but two hours of the day's work. Indeed this is a creditable performance, but the way in which the Bridgeport Metal Treating Co., of Bridgeport, Conn., handles this branch of its work is so systematic that it seems to receive no more attention than any of the other work. Through the courtesy of Mr. Wm. T. Gibson, general manager of the above company, the details of the chain-hardening process, and a description of the general hardening equipment used in the regular work of the company, are here presented.

The chain itself is composed of one-inch links, made in short lengths ranging from ten to eighteen inches, and is used in large quantities by manufacturers of automobile accessories. The material is low-carbon steel, so that carbonizing is necessary before the chain can be hardened. For this purpose the chain is packed in iron boxes with granulated raw bone and is heated for several hours to carbonize the chain to a sufficient depth. As the chain is not subjected to any great strain, the principal reason for the hardening is to secure a surface that will wear well. In packing the chain in the iron boxes, the raw bone is first mixed with spent bone so as to give the mixture more body, for clear raw bone would supply more carbon than necessary, and only result in a waste

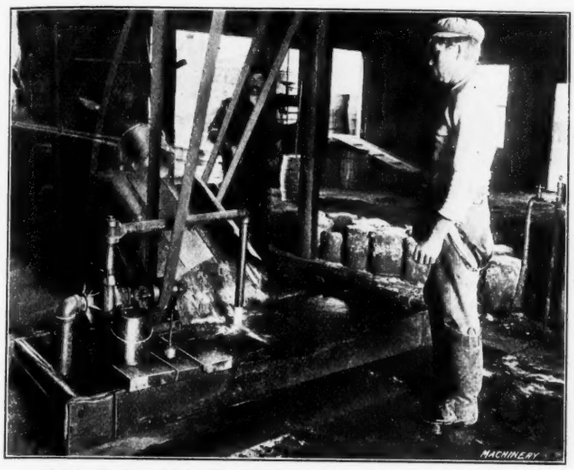


Fig. 1. Tank used for Hardening, and Boxes packed with Chain

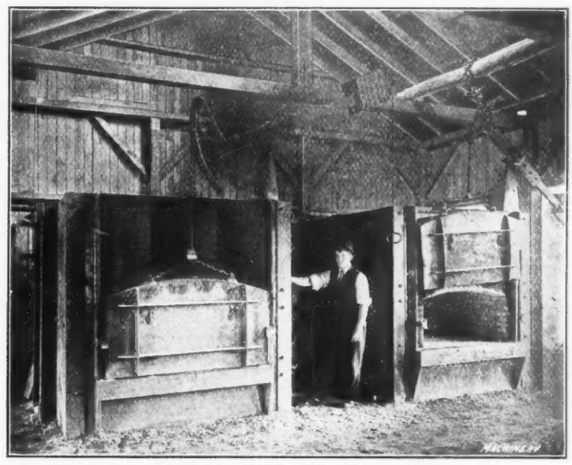


Fig. 2. The Carbonizing Furnaces

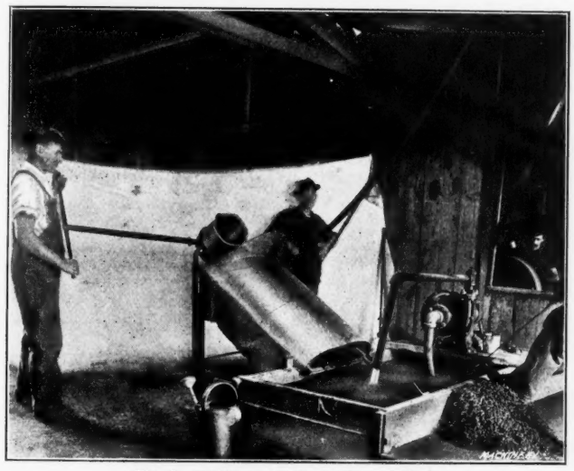


Fig. 3. Ready to harden a Box of Chain

Fig. 4. Hardening an Embossing Die for Silver Spoons

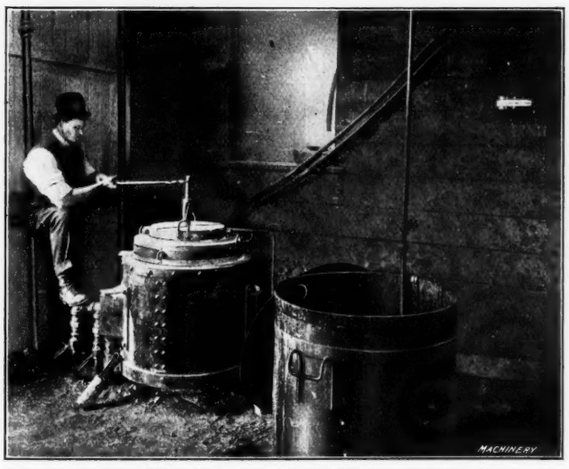


Fig. 5. High-speed Steel Furnace, illustrating the use of the Pyrometer

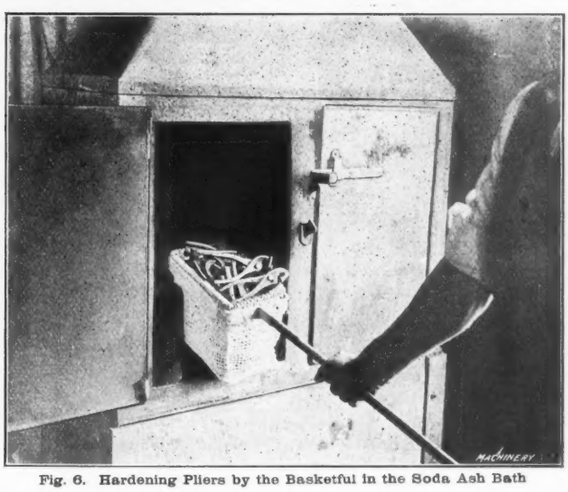


Fig. 6. Hardening Pliers by the Basketful in the Soda Ash Bath

* Associate Editor of MACHINERY.

of the material. In the background of Fig. 1 may be seen a number of the boxes of chain packed and ready for the carbonizing furnaces.

The Carbonizing Furnaces

Fig. 2 shows two of the carbonizing furnaces in which the boxes of chain are heated for hardening. They are of the well-known Rockwell make, being of the over-fired type. These furnaces have displaced the old-style under-fired furnaces that were previously used in this shop. The old-style furnaces burned on an average of 60 gallons of oil per day of ten hours, while the over-fired furnaces consume but 40 gallons of oil in the same time, and give a more uniform heat. As shown in the illustration, the oil and air supply is at the rear. The furnace at the right shows the interior of the heating chamber.

In order to make clear the construction of the Rockwell over-fired type of furnace, the line-engraving Fig. 8 is shown. At the extreme top of the furnace is the combustion chamber, from which the products of combustion are distributed through the perforated arch into the working chamber below. The spent gases are discharged through the outlets at the sides and pass through the space beneath the floor of the working chamber. Fig. 8 also shows the pyrometer arrangement employed with this style of furnace. The pyrometer plays an important part in hardening operations as practiced in the up-to-date shop. In using this type of furnace, pyrometer readings are obtained by passing the thermo-nipple through a small opening in the side wall, near the rear of the furnace. From the extension piece shown, the leads are connected with the instrument that is kept in a more convenient location. Pyrometer readings show that the over-fired furnace is far superior to the under-fired furnace in maintaining even heats.

The Hardening Apparatus

The chain-hardening apparatus, shown in Fig. 1, consists of a tank with a pump attached, so as to insure a good supply of cold brine, and a "shaker" or screen that is agitated to screen the bone from the chain while being turned into the hardening tank. The tank is made of wood, four feet deep,

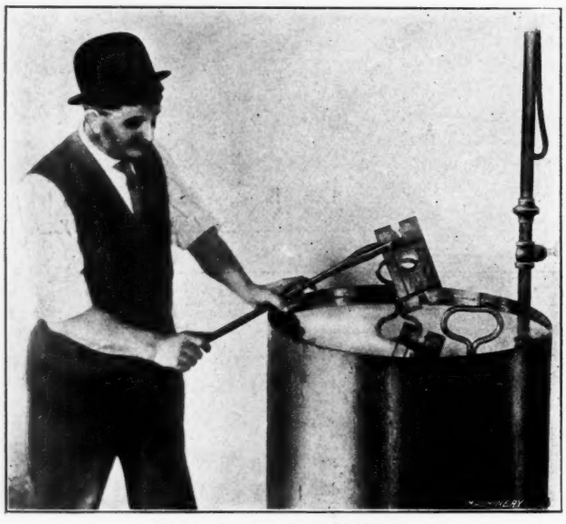


Fig. 7. Quenching a Blanking Die

four feet wide and eight feet long, and is kept filled with natural brine from the ocean nearby. The supply of brine is insured by the pump, shown at one end of the tank. The overflow at the other end permits the warm water to run off; thus the water in the tank is always cold.

The shaker, which is the novel feature of this hardening apparatus, consists of an inclined screen that is automatically shaken by a simple crank movement. In Fig. 3 the screen may be seen just below the guard. This illustration also shows the tank and pump.

Hardening the Chain

Fig. 3 shows the hardening apparatus with a box of chain about to be hardened, while Fig. 1 illustrates the actual hardening of the chain. In this latter illustration the guard has been partly removed to better show the chain. The heavy boxes of chain are taken from the fire by one of the men, and immediately two other men grasp the boxes with the special tongs shown, and take them to the hardening tank but a few steps away. The pump and screen are kept in operation and the contents of the boxes are dumped onto the moving screen. The action of the screen rapidly separates the bone from the chain, permitting the bone to drop into a box under the screen, while the clean chain slides into the tank of brine. The separating of the bone from the chain not only saves time, but also prevents an unnecessary amount of heat from going into the hardening tank. Another advantage of the screening

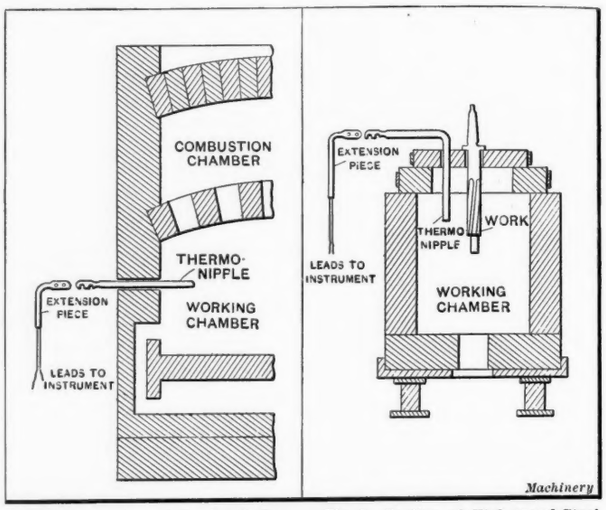


Fig. 8. Section of Rockwell Over-fired Furnace, showing Pyrometer Setting

Fig. 9. Section of High-speed Steel Heating Furnace, illustrating Pyrometer Setting

is the manner in which the chain is spread out and slid into the tank, allowing the brine to get at each link quickly.

Tool-hardening Department

The success that the Bridgeport Metal Treating Co. has had in hardening dies and other fine tools has resulted in the establishment of a business in hardening work from shops that either do not have the hardening facilities necessary, or that do not wish to risk the chance of losing their work in hardening. Fig. 4 illustrates some of this high-grade tool work—embossing dies for silverware, thread tools, special arbors and engraved hobs used in sinking spoon dies. This illustration also shows the foreman of the hardening room in the act of hardening one of the embossing dies that is to be used in striking up spoons.

Previous to heating, the face of the die is covered with a paste of plumbago for the purpose of preventing the formation of scale and to protect the fine engraved lines of the design. After the die has reached the hardening heat, this covering is quickly brushed off, and the die quenched in the tank in the manner shown in Fig. 4. The hardening tank is made from a large hogshead, and, of course, is provided with a generous inlet pipe that discharges upward from a point in the center of the barrel, about twelve inches from the surface of the water. The overflow pipe is set at the opposite side of the barrel.

The high-speed steel furnace shown in Fig. 5 and in section in Fig. 9, is used for hardening high-speed steel cutters, reamers, lathe and planer tools. The halftone also shows the pyrometer. The instrument is suspended upon the wall to the right of the illustration whence connections are made to the thermo-nipple in the furnace. Fig. 9 shows the method of attaching the pyrometer to the high-speed steel furnace. In this illustration the heating details have been omitted. The thermo-nipple in this case is of a bent form, being suspended through the top of the furnace. In the foreground in Fig. 5 is the oil tank for hardening high-speed steel.

The method of heating pliers in quantity is shown in the illustration Fig. 6 in which the hardener is putting a basketful of pliers into the heating bath. The heating bath is composed of soda-ash, a substance much the same as barium chloride, although it has a lower melting point.

Fig. 7 illustrates the hardening-room foreman in the act of quenching a blanking die in one of the hardening tanks. This tank is made of sheet iron. The two handles at the sides are for raising the sieve that is placed in the tank to catch work left there to cool. It will be noticed that in hardening these dies, the hardener dips them into the tank, end first, and not face down. To the experienced hardener, this point is self-evident, but the apprentice usually attempts to harden a die "face down," irrespective of its dimensions.

In addition to the chain and tool hardening, this company does a great deal of hardening of a general nature, and specializes in the heat treatment of gears and similar work.

* * *

"GALVANIT" OR PLATING POWDER PROCESS

The new and much-discussed English "galvanit" process for producing metallic coatings (see MACHINERY, engineering edition, April, 1910, page 605) was described by Arthur D. Little, Inc., of Boston, in their recent annual report as official chemists to the American Brass Founders' Association. The details of this method as shown by the two patents recently taken out in London are substantially as follows:

A wet rag dipped in the plating powder mixture is rubbed on the surface to be coated. If this surface is metallic, or at least electrically conductive, electrolytic action is set up in the wet mixture which is rubbed on, and the desired metal is deposited on the surface. A suitable mixture for nickel plating is stated to be: 60 parts nickel ammonium sulphate; 3 parts metallic magnesium; 30 parts chalk; 7 parts talc powder.

The nickel ammonium sulphate dissolves when the powder is wet, forming the electrolyte; the magnesium being highly electro-positive, forms the anode, while the surface to be coated forms the cathode. There are therefore produced a number of short-circuited electrolytic cells with particles of magnesium as anodes and the surface as cathodes, with the result that nickel is deposited on the surface. The ammonical salt is stated to be specially advantageous when the surface to be plated is greasy and the reaction tends to dissolve the grease and facilitate the plating. The talc powder and chalk serve both as abrasives for polishing the coating and to prevent the ammonium sulphate from acting on the other ingredients by absorption of moisture from the atmosphere. A mixture of the following composition for plating zinc on iron or copper is suggested: 45 parts zinc dust; 15 parts ammonium sulphate; 3 parts magnesium; 30 parts chalk; 7 parts talc.

* * *

COW'S-HORN CUP PACKING FOR DEEP-WELL PUMPS

Most of the petroleum produced in the United States is pumped from the wells, as few oil wells flow after the first year or two. Fitting up oil-well pumping rigs and pumping wells are two of the chief occupations in an old oil field. The pumps are especially designed for high pressure, having a small bore and a long stroke. The hydraulic pressure under which they operate is often as high as 1000 pounds per square inch, and is commonly 500 pounds or more. The common design of plunger provides four cup leathers in series. The material used for the cup leathers comprises a variety of materials, including ordinary leather, vulcanized fabric and cow's horns. The cow's-horn cups are made from sections of horn turned and bored to the common packing leather shape, and are given a treatment which increases their durability. But the value of cow's-horn cups seems to lie chiefly in their expansion without causing undue friction. As the cup wears it expands to fit the bore of the cylinder, but the hydraulic pressure is not transmitted through the cup rim to the cylinder walls in the same degree as with leather cups, and the cow's horn wears about twice as long as the best leather cup under average conditions. They are made about 1¾ inch in diameter, being confined in size, of course, to the diameter of the average horn near its base.

* * *

When men get cold feet on concrete floors it is a literal and not a figurative case.

THREADING CHASER TROUBLES AND REMEDIES*

By C. G. H.

The troubles encountered by the toolmaker and toolgrinder in keeping up a very large assortment of thread chasers of various designs for cutting soft steel, tool steel, malleable iron, and especially brass, are many. There are also numerous methods advanced for overcoming the various troubles encountered, but they, like many of the theories regarding the manufacture and re-grinding of threading chasers, do not always prove satisfactory when put into practice.

Owing to the large number of thread pitches used on different diameters there are, of course, many angles to contend with. This fact makes it impossible to control a cutter of the chaser class, as we do the single-pointed lathe tool for brass, which is a tool used principally by brass finishers and machinists. This tool is ground with very little side clearance and with usually no top rake. We know that if the brass threading tool is not made in this manner, it is likely to run ahead of the feed, and produce a rough and uneven finish. This is the trouble which is also encountered

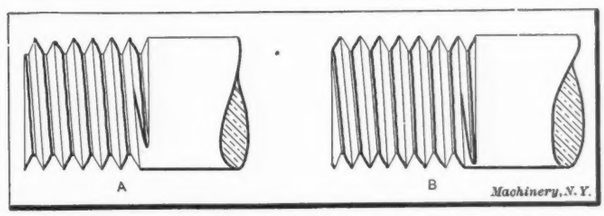


Fig. 1. Conditions of Thread which denote how the Chasers are leading

with threading chasers held in a die-head, where they are required to make their own lead; they run ahead of the pitch, sometimes, to such an extent as to cut the thread entirely off the piece. In other cases where the chasers are more correctly ground, they leave the back side of the thread rough, as shown at *A* in Fig. 1, which indicates that the die is leading ahead too fast. Sometimes just the opposite condition exists, that is, the front side of the thread is rough, as shown at *B*, in Fig. 1. This is caused by the die not leading fast enough.

The condition of the thread produced on both the front and rear sides should always be noted, as this is a guide which can be used to correct the trouble. Where it is necessary for the thread to fit sufficiently close to make a watertight joint, it is desirable that the threads should be correctly formed. The ideal way to govern the leading of the die, is to grind more or less relief in the throat of the die, as the case demands, similar to that shown at *A*, Fig. 2. The more relief given to the die, the faster it will lead, and the less relief the slower it will lead. Unfortunately it is seldom possible to have a very long throat in the dies, especially on small brass work, where it is necessary to cut the thread up to a shoulder. This condition makes it impossible to entirely control the free cutting of the chasers by the amount of relief in the throat.

Where a set of chasers is to be used for cutting up close to a shoulder, instead of grinding the throat of the dies back, as shown at *A* in Fig. 2, the first two or three teeth in the chasers are lapped with a strip made of sheet brass, as shown at *B*, Fig. 2. This strip is charged with carborundum and oil, and is moved across the first two or three threads by hand. It should be held at the angle required to give the thread more or less side clearance as desired. The side of the thread to lap depends upon whether it is desired to make the die lead faster or slower. If the angle of the thread *a* shown at *C* in Fig. 2 is reduced, the dies will lead slower. The working edge of the lap should be made with an angle of about 50 degrees, so that it will be possible to get to the

For additional information on this subject, published in MACHINERY, see "Threading Chasers—Dimensions," January, 1908; "Circular Chasers for Internal Threading," May, 1908, engineering edition; "Grinding Threading Chasers for Brass Work," November, 1908; "Grinding Threading Die Chasers," November, 1907; "Recutting Thread Chasers," October, 1904.

bottom of a 60-degree thread, and touch only the side desired. When lapping a set of chasers in this manner, they should be tried out occasionally on a piece of work to see whether they are producing the desired results. A very slight change on the first two threads will generally be sufficient, leaving the rest of the cutting edges perfect, and free cutting.

Chasers should be sharpened frequently and the lightest possible grinding cut should be taken from them. The chasers should not be allowed to become so dull that it will be necessary for the grinder to remove so much material that the previous corrections on the chasers by lapping are entirely removed. The writer has seen some mechanics correct chasers with a three-cornered file, by filing the threads clear across the chasers instead of lapping the first two or three threads. Filing can be used sometimes for making the corrections, but unless the file is handled with a certain amount of dexterity, the results are not always gratifying. Frequently a chaser in a set is not so sharp as the opposite one, which results in the stock being forced over the sharper chasers. This only aggravates the condition, and makes it more difficult to find which chaser is producing poor results. Filing the chasers also causes them to burnish the thread instead of cutting, which puts an excessive strain on the die-heads, and when of the opening variety they frequently refuse to trip. Excessive heating of the work being threaded is also caused by the friction, which results in unequal expansion, and makes it difficult to assemble the parts, if they are to fit at all closely.

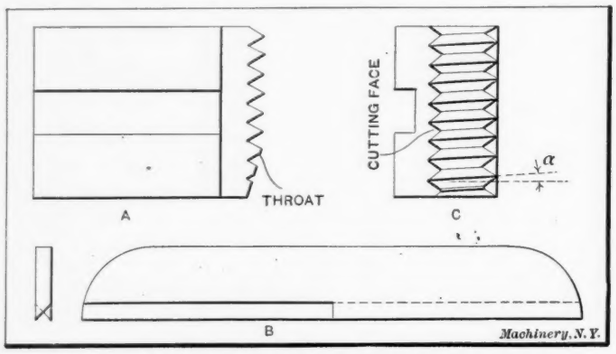


Fig. 2. Showing how the Throat of the Chaser is relieved—Tool for Lapping the Sides of the Thread

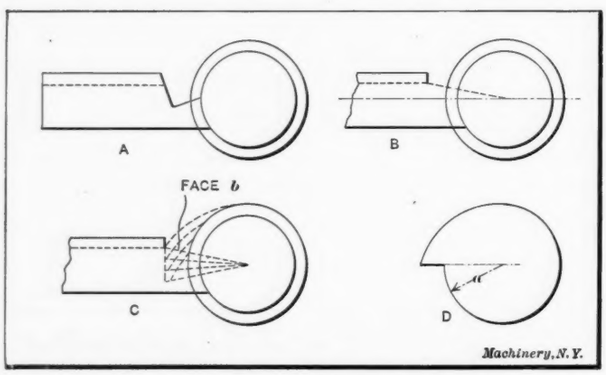


Fig. 3. Templet and Method of Grinding Threading Chasers for Cutting Different Materials

The angle of the cutting face or top rake of the chaser is another point about which there is a considerable difference of opinion. In deciding on this angle, the material to be cut is the governing feature. When cutting machine steel, tool steel, or yellow brass, considerable top rake is necessary, as shown at *A*, Fig. 3. The idea of giving the top rake to the chaser is to produce a curling chip, so that the metal can be removed without undue friction. On cast brass the conditions are quite different, according to the alloy used. In most cases it is advisable to grind the cutting face radial as shown at *B* in Fig. 3.

A point which has caused considerable confusion in the minds of mechanics is the constantly changing appearance of the cutting face of the chasers, after they have been resharpened a number of times. Referring to *C*, Fig. 3, it will be seen that in order to maintain the top-rake, the angle, if taken with reference to the chaser itself, and not with reference to its position in the die-head and the center of the work, seems to be greater as the chaser is ground away. This the writer believes is the reason that a difference of opinion exists regarding to the grinding of the chasers. It is important, however, that the cutting face of the chaser should always bear the same relation to the work, and for this reason it is desirable to have a templet to grind the chaser to. The templet shown at *D* in Fig. 3 has been found very useful for grinding thread chasers for cast brass. This templet is made of thin sheet steel and is held in the bottom of the thread. The radius *a* is made one-half the diameter of the work on which the chasers are to be used. The projection on the templet is ground to a radial line. By holding this templet in the bottom of the thread in the chaser, and grinding the face *b* to the projection on the gage, the cutting edge will always pass through the center of the work.

The writer has found by experience that chasers which gave satisfactory results in one die-head did not work at all when put in another die-head. However, it was found after considerable experimenting, that the relief in the throat of the chaser should be controlled very closely; in fact, a difference of from 0.002 to 0.003 inch more throat relief would sometimes cause the thread to strip badly. This led to an investigation, and a comparison of all the releasing die-heads revealed a wide variation in the width of the slots. This accounted for the chasers working correctly in one die-head and poorly in another, as the change in the width of the slots would allow the chasers to tip more or less, thereby changing the throat relief.

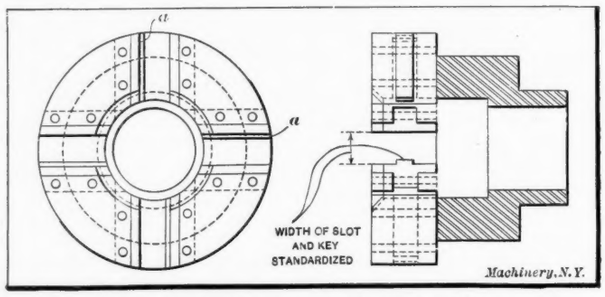


Fig. 4. Method of repairing a Geometric Tool Co.'s Die-head, so that the Chasers can be interchanged

In order to make a chart showing the exact position of the chaser in the throat grinding machine, so that it could be duplicated and used in any head when ground, it was found necessary to cut out the slots in the die-heads and insert hardened and ground tool-steel blocks *a*, shown in Fig. 4, in such a manner that they could be removed when worn and new ones put in their place. This permits keeping the slots in the die-head in good condition, and also facilitates making the chasers interchangeable. When a set of chasers of, say, 1 inch in diameter and 14-inch pitch, for example, is found by experiment to be correctly ground, the position they occupy in the throat grinding machine is marked on the chart so that it is possible to duplicate the grinding. Chasers which are made slightly taper, say about ¼ inch to the foot, have been found to work much better on some jobs on account of good clearance conditions. It has been found that five times as many pieces can be threaded with such dies before resharpening, as can be done with ordinary straight ones.

* * *

What is believed to be the largest ingot ever produced was lately cast by Cammell, Laird & Co., Grimesthorpe Works, Sheffield. This ingot weighed 130 tons and was over 15 feet long, about 9 feet wide, and 5 feet thick. From it a plate was rolled 18 feet, 6 inches long by 10 feet, 9 inches wide, the thickness of which was 25 inches. This plate weighed approximately 90 tons.

SPECIAL TOOLS AND FIXTURES

By JAMES H. CARVER*

The accompanying illustrations show special tools and fixtures which the writer believes will be new to many. The fixture shown in Fig. 1 is a small tool-holder to be bolted to the clapper of a shaper or small planer, and which, with the round tool inserted as shown, makes a very handy and efficient rig for machining small blanking or trimming dies to shape, or for any other job for which a projecting tool is required. Anyone who has experienced dressing a tool of this sort many times to suit different jobs will appreciate the value of this device. The plate *A* is bolted and doweled to the clapper as shown, the bolt and round nut, occupying the hole generally filled by the toolpost. The inserted tool is made from round stock, and, when of small size, the split bushing is used as shown, the larger size filling the hole in *A*. When a cheaper tool is needed, that shown in Fig. 2 is satisfactory. This is formed from an ordinary piece of tool steel, into which is fitted the tool, made from round stock, and having a taper of about ¼ inch to the foot. It can be knocked out with a hammer blow, when the point is to be shifted or another style of tool inserted.

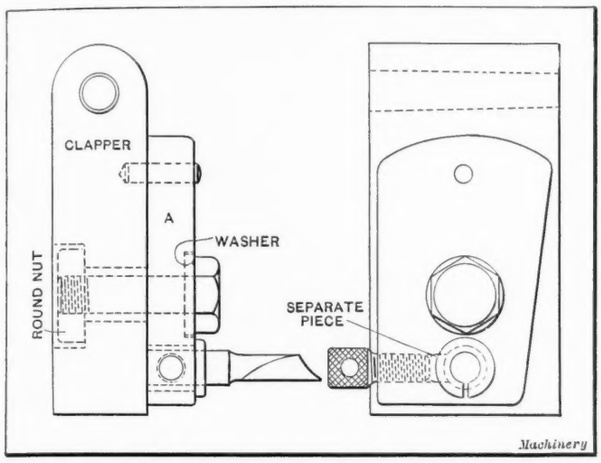


Fig. 1. Fixture to be attached to Planer or Shaper Clapper Box, for Use in Machining Small Blanking or Trimming Dies

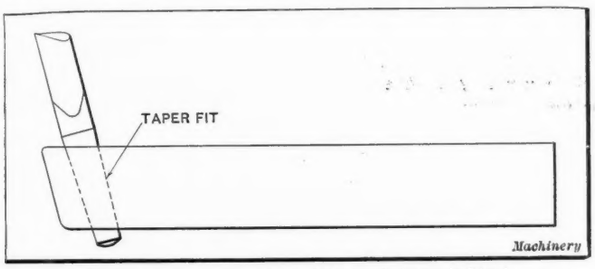


Fig. 2. Simpler Adaptation of the Tool shown in Fig. 1

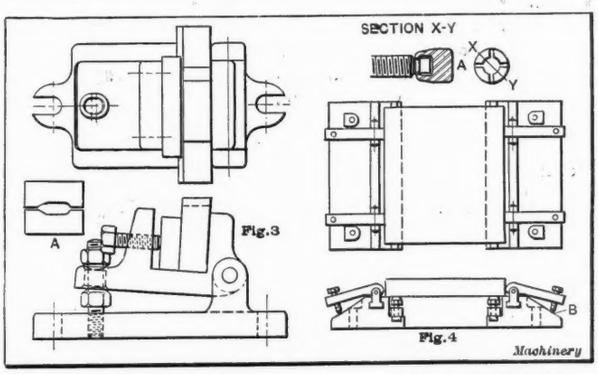


Fig. 3. Vise for Holding Blanking Dies in Shaper, to give Clearance

Fig. 4. Vise for Holding down Work in the Planer

The fixture shown in Fig. 3 is for use on a shaper when forming blanking or trimming dies, such as the one shown at *A*. Two bolts are used in the fixed jaw, for holding the work. If the fixture is large, cast iron may be used, steel being employed for the smaller sizes. In Fig. 4 is illustrated a fixture for holding down work on the planer. In one case in mind, it was found very useful while planing die-holders. One pattern, of course, does for both sides of the fixture. The tip *A* may be used on the bolts at *B*. The castings can be either bolted to the planer at the bolt holes shown, or pinned down by the adjustable pins shown in Fig. 5, which are made of cold-rolled steel; the pointed pin may be made from an ordinary set-screw. Adjustable blocks used in connection with bolts and U-straps are shown in Fig. 6. On the slotter these will be found invaluable, but on the planer and shaper, their heights will probably make them useless. Parts *A* and *B* can be sawed from rectangular cold-rolled stock, the lower part of *A* being turned round to fit a drilled hole in *B*.

In Fig. 7 is illustrated a chuck much used in connection with drop-forge dies, where an impression requiring lathe work is necessary. When an impression is used on both top and bottom dies, this fixture insures a correct line-up in one direction, the test-indicator of course making it correct in the other. When many bolt-header dies requiring lathe work are being made, the fixture illustrated in Fig. 8 is well worth making, a test-indicator being used to true up the job.

Fig. 9 shows a good substitute for a commercial chuck and is meant for use on large or small boring-mills. The four pieces forming the rectangle are made from rectangular cold-rolled stock, and have a screw tapped into each jaw. The square-threaded screws and collars at *A* are made in one piece, with a separate pinned collar on the other side. The four cold-rolled pieces are held by fillister-head screws, tapped into the table. A jig for drilling holes in a circle, on rather large work, is shown in Fig. 10. This is used on a radial drill, but may be used to advantage on other style drills, if the size of the table will permit. The round bar *A*, which is fitted into *B*, may be adjusted to any radius for drilling holes in a circle. Any number of slots may be machined in movable plate *C*, the divisions being divisible by the number of holes most likely to be used. The work is held by a lathe chuck, which is bolted to dividing plate *C*. Latch *D* is lifted as each hole is drilled, and the movement made for the next hole.

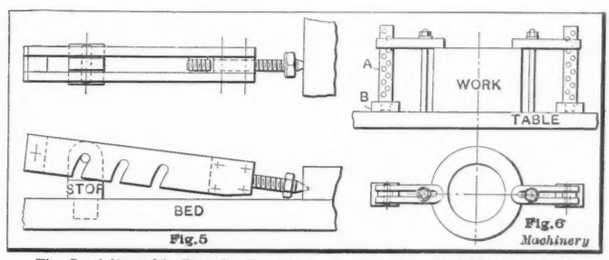


Fig. 5. Adjustable Pins for Securing Flat Work on Planer Table

Fig. 6. Adjustable Blocks for Use with U-straps

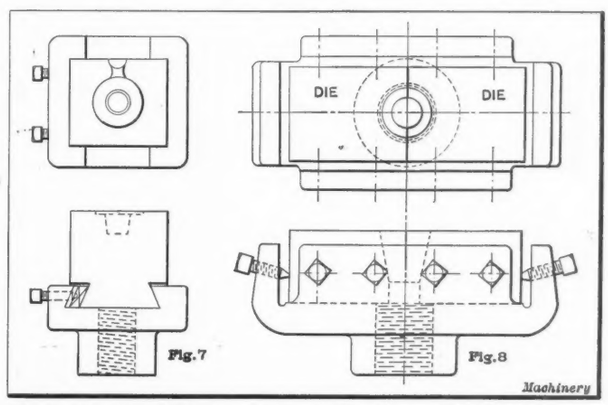


Fig. 7. Chuck for Holding Drop-forged Dies

Fig. 8. Another Type of Chuck for Securing Bolt-header Dies

Fig. 11 shows a jig for use on a radial drill, whereby a job of the nature suggested by the small figure shown at *A*, may be drilled. The stop at *B* is of the same design as that used in Fig. 10. The bushing holder at *C* may be made adjustable,

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if necessary, making it possible to drill holes in circles of different diameters.

A tool used in the drill press for cutting circular plates from sheet metal is shown in Fig. 12. The bar *A* and tool *B* are both made adjustable. The cutting tool is made from round stock, having a flat surface for the set-screw seat. When plates are cut singly, a hard-wood board is generally placed between the work and the machine table; when not cut in this manner, the

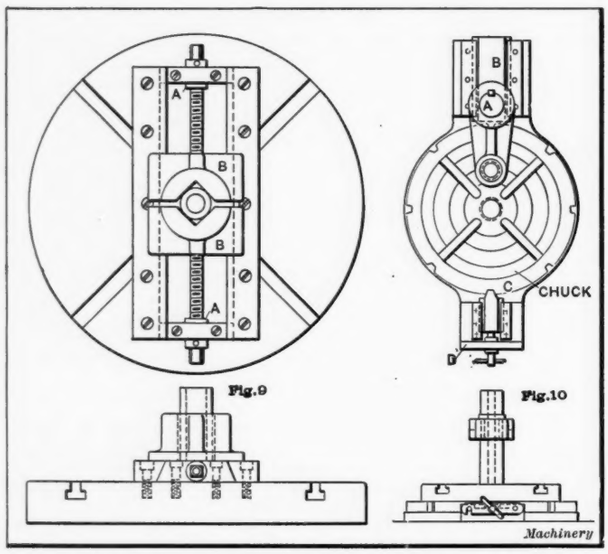


Fig. 9. Substitute for the Commercial Chuck for Use on the Boring Mill

Fig. 10. Jig for Drilling Holes in a Circle

number of plates cut at one time is limited by the design of fixture. In Fig. 13 is shown a fixture for cutting circular pieces of emery paper, for use on disk grinders. The paper is furnished by the manufacturers in rolls, of widths, 19 inches, 21 inches, etc., and is cut into circular sheets just a little larger than the diameter of the disk on the grinder. A 16-inch

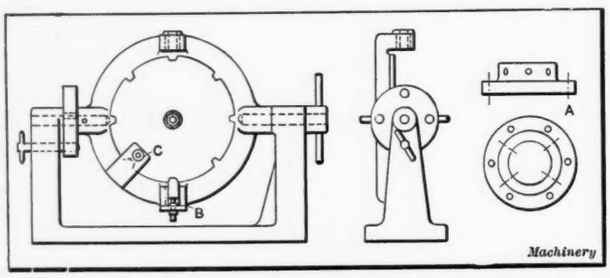


Fig. 11. Drill Jig for equidistantly Spacing Holes in such a Piece as that shown at A

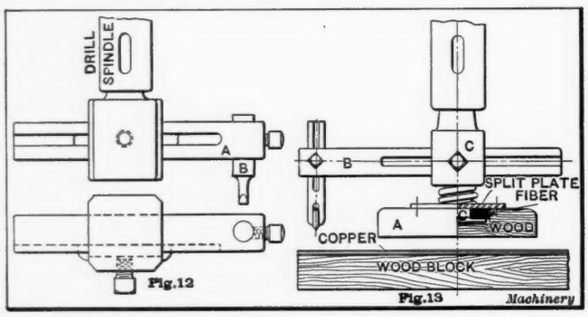


Fig. 12. Tool for Cutting out Circular Metal Plate

Fig 13. Similar Tool used for Cutting Abrasive Disks

disk would have, say, a 16½-inch diameter disk of paper, which would be trimmed to the size of the disk after being mounted. A square wooden block is laid on the drill-press table; this block has a thin sheathing of copper fixed to the top surface, by means of wood-screws. The paper is fed from the roll, between the circular wooden block *A* and the copper sheet; the drill spindle is lowered, which holds the paper firmly, by means of the block and spring. The downward movement is continued, when the circular cutting tool comes in contact with the paper, cutting the circular piece to a size depending on the adjustment of bar *B*. The parts in line with the drill spindle are the body *C*, which is made in one piece, the spring securing plate, fiber washer and circular wooden block. The securing plate is held on the block *A* by means of wood-screws, and is split to allow the parts to be assembled. When cutting the paper, block *A* is, of course, stationary, body *C* turning in it.

* * *

REMARKS BY THE ON-LOOKER

In looking over MACHINERY for August, I got to thinking of what an amount of information is given therein for twenty cents. While the object of business is to make money, I think there are two kinds of business which embody something more—the idea of brotherly love or philanthropy. One of these is life insurance and the other journalism. In your case, you give out each month, not a mere outline of your individual views, but those of others also, allowing them to be weighed by the readers.

I am not quite able to make up my mind which is the more interesting portion of your publication (I think it certainly could be called a magazine), the advertisements or the reading matter.

You mention small shops and their equipment in one of your editorials, and on that particular point I have a whole lot to say, but not just now; I want to advise anyone about to start a small shop to cut loose from the past and not consider that a shaper, planer, drill press and lathe, with perhaps an emery wheel, is about all that is necessary to begin with—and to keep on with. In a small machine shop, to those who really know machine shop work, the tools outlined are all right, but the world advances and new methods come up. Take, for instance, the surface finishing machine; it would be perhaps a wiser investment than a shaper. In other words, in starting a machine shop to-day a proprietor has to remember that what he used to have, or what his father had, while in many cases all right at the time, must be added to. A close scrutiny of the advertising pages of MACHINERY will give a pretty good idea of what to add.

In your editorial you speak of the necessity of awakening some people to their own capabilities by a good hard jolt. Permit me to say that there is a whole sermon in this. In my personal experience I have often seen much good come out of what was apparently a misfortune, in developing human character.

In the practical articles you show an illustration of the leveling of a lineshaft by means of a suspended straightedge. This is something I hardly see the use of; why not lay the leveler on the shaft itself?

The welded joint shown is a practical example of what can be done with the oxy-acetylene system, and it seems to present the solution of many leak troubles. It is now proposed to weld flues in locomotive boilers by this system. I have my doubts about its value there, but certainly the uses of this valuable process are not yet half worked up.

In the planer-rail elevating device, the author fails to mention one very decided advantage which it has, or can have; that is, by elongating the holes in the half of the coupling which is not tapped, the two elevating screws can be readily timed. This is a decided point of advantage in the arrangement.

Mr. Hamilton's article on rolling threads will save those who are interested in the subject an immense amount of guess-work. Here, again, the price of twenty cents for the magazine seems absurdly small.

The question of die-casting is one that is becoming daily more interesting. In the Veeder products, its value is most clearly brought out, but are we any more than just starting in this matter? I think not. As time goes on I look to the foundry to effect great savings for us. I suggested and put into practical use the idea of having certain surfaces on machines, which had heretofore been tooled, so cast by reducing their area, that they came out practically perfect, that is nearly enough perfect for the particular job, and I believe this idea can be carried much further.

There is no country in the world, save the United States,

where such detailed explanations of methods and ways would be given in a journal as those given by you in relation to press work and die making. I cannot imagine the publication of such articles in any foreign country being possible. They would lose the writer his job, and wild horses could hardly wrest the information from him if he were a proprietor.

Many years' living abroad gives me the right to speak of cast iron. (I mean by "living," making my living as an engineer in foreign countries.) Therefore I speak out of knowledge in the matter of soft or hard iron. I do not take the view that the softer material absorbs a lubricant advantageously. Of course oil will run into a hole under proper conditions, but it is hardly obliging enough to run out again, and in comparing hard and soft iron I should be very wary in accepting the value of one over the other until I knew that the care given to both was just the same.

It is sad to find the name of Beale among those who have "washed up" for the last time and gone home forever. Truly his existence has been of great value in the mechanical world. What more can a mechanic ask than an epitaph which reads: "What he did he did well," and this can be said of him.

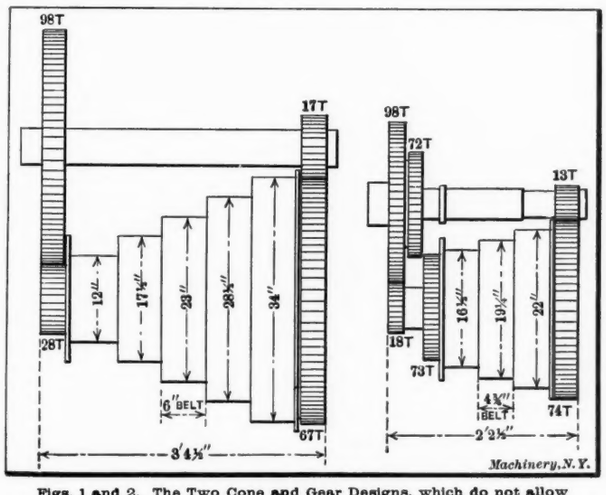
W. D. F.

* * *

DOUBLE BACK-GEARS

By T. BARTON*

In the March number of MACHINERY "Racquet" draws attention to the increased driving power obtained by the use of double back-gearing. It is only natural that the double back-gear should give more power, as with this arrangement two-thirds of the speeds are obtained through gearing, against one-half with the ordinary single back-gear. The two examples given by "Racquet" to show the superiority of the double back-gear, see Figs. 1 and 2, are not very well selected, because the two cone pulleys are of different designs, one being a "flat" cone, and the other a "steep" cone. By this is meant that for the double back-gear, Fig. 2, the belt is shifted over the whole range of the cone before changing the countershaft speed, while for the single back-gear, Fig. 1, the countershaft



Figs. 1 and 2. The Two Cone and Gear Designs, which do not allow a Fair Comparison

speed is changed each time the belt is shifted, the two countershaft speeds being used consecutively on each step of the cone.

"Racquet" is only comparing double with single back-gears, and not criticizing cone-pulley design; therefore, for a fair comparison, it is hardly correct to show the double back-gear with a cone which gives a much higher average horsepower than it would if designed in the same way as the cone in Fig. 1. If this large cone were designed in the same way as the small one, it would be found, taking average horsepower, that instead of the small cone being 12 per cent more powerful than the large one, the large cone would be 27 per cent more powerful than the small one. Thus a large part of the advantage is due, not to double back-gears, but to different designs of cone pulleys.

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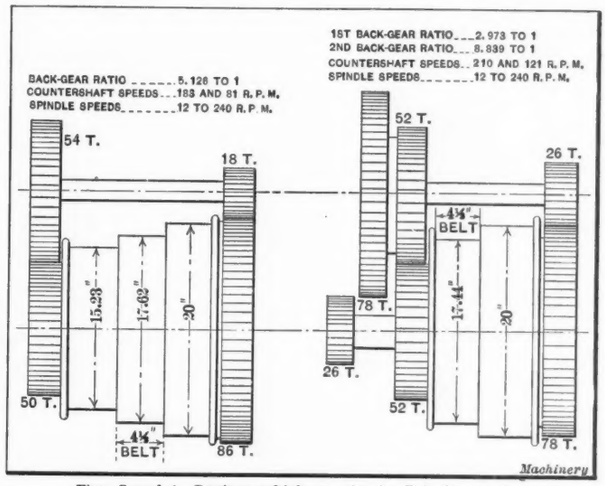
It would appear that but little consideration is given to the matter, if cone pulley drives are compared by their average driving power. The horsepower put into a machine is governed by the number of square inches of belt passing over the pulley per minute. This is at its maximum in a cone drive at the point where it is usually least needed, that is, at the highest spindle speed, on work of small diameter, and at its minimum on the lowest spindle speed, on work of large diameter. Therefore the lowest spindle speed is the weak point in the speed range, and comparisons should be made relative to this. To take the average power is misleading, and is as sensible as it would be to take a chain having links of varying



Figs. 3 and 4. Designs which permit of a Fair Comparison

strengths, and find the strength of the chain by taking the average. "A chain is no stronger than its weakest link," and the same principle applies equally to machine tools.

Would not the best way of making a comparison of the relative power obtained from single and double back-gearing be to fix on a certain speed ratio and number of speeds, and then design a cone and gearing to give these speeds according to each method? This has been done in Figs. 3 and 4. A speed ratio of 20 to 1 is assumed, with twelve speeds. The countershaft speeds specified give 12 to 240 R. P. M. Twelve speeds are used because this number can be obtained under the same conditions, that is, using two countershaft changes with each headstock, etc. The large step of the cone, and width of step is the same in each case. On the lowest spindle speed, the double back-gearing shows an advantage of 73 per cent. This advantage would naturally be greater with a higher speed ratio and less with a smaller one. As the space occupied by each arrangement does not vary greatly, this increase in power would seem to warrant its adoption where possible.

The "flat" design of cone, as shown in Fig. 2, is generally spoken of as being the nearest approach to the single-pulley drive. It may be, as regards appearance, but it is not so in point of power delivered. The advantage of a single-pulley drive is that the power is constant. With any of the usual types of cone drives the power varies, but the variation is much less when the unfashionable "steep" cone is used than when the "flat" cone is used. The factors which generally determine the employment of the "flat" cone are: ease of belt shifting, and appearance, the "flat" cone looking much more impressive and powerful on a machine than the "steep" cone. This latter reason probably carries the most weight.

* * *

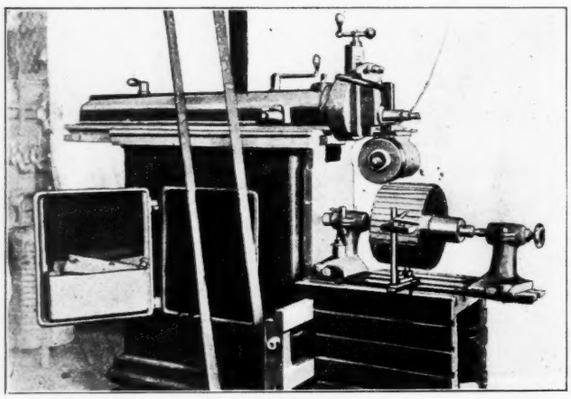
The close interdependence of the various activities in modern life was well illustrated during the recent labor strike in London. The dock workers' strike had an immediate and paralyzing effect upon the means of communication within the city. This was due to the shortage in the supply of fuel for motor omnibuses and taxi-cabs. The difficulties in obtaining coal also had a serious effect on the electric generating stations, and had the strike not been so quickly settled, it would have tied up practically all the urban railways and street car lines in London, although none of these were directly involved in the labor strikes.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

SHARPENING A HOB IN A SHAPER

A small shop recently had occasion to sharpen a hob which was larger in diameter than could be accommodated by the tool-room grinder. The accompanying illustration shows the ingenious method devised to overcome this difficulty. The center heads were removed from the grinder and placed on the shaper, as shown. As the hob arbor was considerably longer than the shaper, a parallel strip was fastened to the table and the center head attached to it. An electrically driven center grinder with a wheel formed to the desired shape was



Method of Sharpening Hob Larger in Diameter than the Capacity of the Grinder

set up in the tool-holder of the shaper, and tne ram adjusted to give a feed of about 30 feet per minute. As the flutes in the hob had been cut and milled with an index-head, a "snap stop" was fastened to a bracket and located in the flutes, as shown. This stop was sufficient to insure the accurate indexing of the work, the hob being revolved by hand.

Myerstown, Pa. E. J. CARLSON

PRESS TOOLS FOR ALUMINUM SHELL

The spoked aluminum shell shown in Fig. 1 is about four inches in diameter and one inch deep. It has four spokes, or arms, radiating from a hub in which a shaft hole and four rivet holes are punched. These holes are used for attaching the aluminum shell to the bearings of the hub on which it is used. Stiffening "lips" around the openings and spokes are formed, and the ribs or spokes themselves are embossed to add

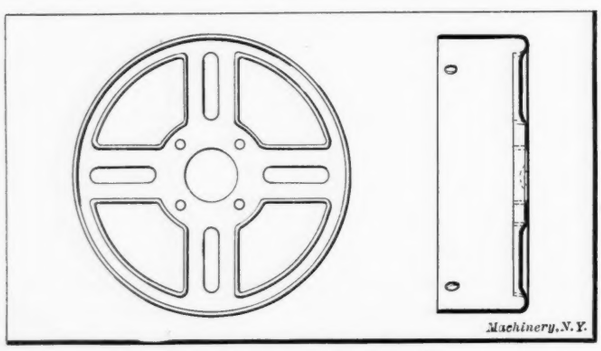


Fig. 1. Aluminum Shell to be made

to the strength of the shell. Four rivet holes punched through the rim of the shell serve to attach it to an exterior band.

This shell was made in the following manner and with excellent results: The blanking, drawing and embossing is done in one operation in a double-action press, using the die shown in Fig. 2. The blank holder *A* is made of cast iron, and a hardened tool-steel blanking die *D* is fastened to it, which not only acts as a die, but also serves to hold the blank in position while the drawing operation is taking place. *B* is the cast-iron drawing punch, to which is attached a hardened steel face *K*. This face *K* contains the embossing recess for the spokes, into which the metal is forced by the embossing punch *H* held to the lower member. The punch *H* also acts as an ejector after the drawing and embossing operations have been

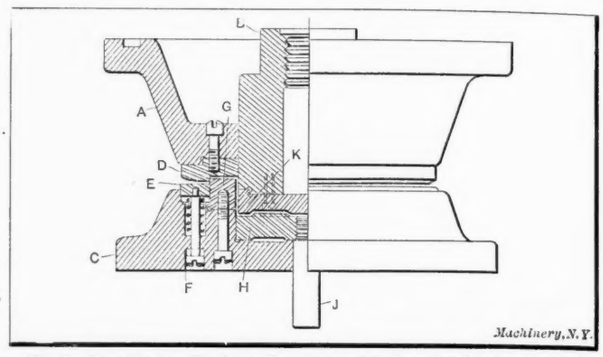


Fig. 2. Combination Blanking, Drawing and Embossing Die for the Shell

completed, and is actuated by the stem *J* and the knock-out mechanism of the press.

The die-shoe *C* is made of cast iron, and is bored out to receive the blanking punch *G* over the inner edge of which the shell is drawn after blanking. The stripper ring *E*, which is made of soft steel and passes around the periphery of the die *G*, is limited in its travel by the shouldered screws *F*, and acted upon by six helical springs. There are several vent holes in the drawing punch and through the plate *H* and the base of the die-shoe, the purpose of which is to allow the air to escape while drawing, and enter while stripping and ejecting the shell. The shell is drawn entirely into the ring *G*, and of course, must be trimmed afterward. This is performed in a trimming lathe, although similar shells are sometimes drawn to the depth required, and a flange left on them, so that they may be trimmed off by a simple blanking die. However, the

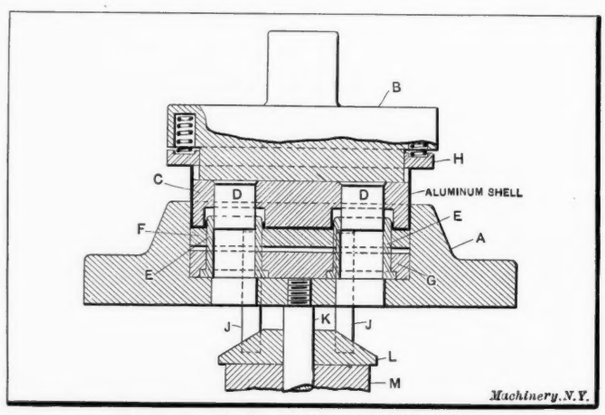


Fig. 3. Combination Piercing and Ribbing Die

method of handling this operation lies entirely with the designer, although it should be governed to some extent by the requirements of the shell.

After the shell is drawn into cup form, the next operation is to pierce the openings to form the spokes, and turn up the "lips" around these openings. Both these operations are performed in the die shown in Fig. 3, which is held in a single-action press. The die-shoe *A* and the punch-holder *B*, respectively, are made of cast iron, the die-shoe being bored out to receive the soft-steel die carrier *G*, and the ejector plate *F*, which is also made of soft steel and is actuated by four studs *J* resting on a cast-iron plate *L*. This cast-iron plate *L* is pressed upward by a rubber pad *M* which slides on stud *K*. The die-bushings *E* are flanged on the bottom, as shown, and are held in the carrier plate in the usual manner. They serve not only

as dies for piereing, but also as drawing punches to draw the stiffening "lips" on the shell. The drawing die *C* is held on the punch-holder *B*, and carries the piercing punches *D*, which are set ahead of the drawing die so that they will pierce the stock before the die begins to draw the "lips." A stripper ring *H*, actuated by coil springs as shown, is limited in its travel by the drawing die *C* upon which it comes to rest on the upstroke of the ram. All the screws and dowel pins used for holding the various members in their respective holders are omitted for the sake of clearness.

The shell is now ready to have the holes around the rim and the small holes in the bottom pierced. These operations are accomplished in the die shown in Fig. 4 which is held in a single-action press. A circular disk *B* of cast iron serves as a base for the die, and to it is attached the die-anvil *K*, of soft machine steel. Die-bushings *L* and *M* are driven into the anvil *K* for piercing the holes in the rim and in the bottom of the shell. Recesses are cut in the block *K* to receive the "lips" around the spoke openings. The cast-iron punch-holder *A* carries two flat springs *J*, which serve to hold the shell on the anvil when the holes are being pierced. The punch-holder *A* also carries four studs *F* (only two of which are shown) that operate the piercing punches *G*. These piercing punches *G* fit in blocks *H* held to the die-bolster, and are retained in the blocks *H* by the small studs *N* working in elongated holes in the block. These small studs or pins *N* also serve to prevent the punches *G* from turning around, so that their beveled ends are always presented properly to the studs *F*. The punches

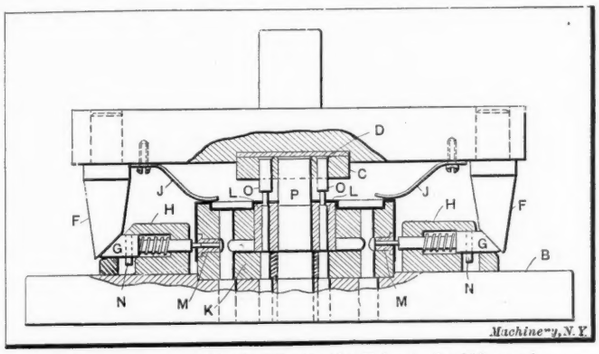


Fig. 4. Punch and Die for Piercing the Holes in the Sides and Bottom of the Shell

G are withdrawn when the ram of the press ascends, by coil springs, as shown. The punches *O* and *P*, for piercing the holes in the bottom of the shell, are held in a machine-steel block *C*, which is backed up with a hardened tool-steel block *D* inserted in the punch-holder *A*. These blocks *C* and *D* are doweled together and held to the punch-holder.

Making this aluminum shell in the manner described, gives a uniform product, and the tools are of such a character that they are easily repaired and are not very costly. While these tools are of a special character, a number of the features incorporated in them could be used for a variety of purposes.

Detroit, Mich. ARON LAWRENCE

MAKING AN IRREGULAR HARDENED PUNCH

The accompanying illustrations show a punch and die for cutting out two pieces at the same time, these pieces being of different lengths, as shown in Fig. 1. The factory using these pieces had too much work on hand in the tool-room to make the punch and die, so they let out the contract to an outside firm doing such work. In due time the punch and die was delivered, and judging from its appearance the firm had done a very good job, especially on the punch, which was drawn to a dark straw color. The fact that the punch was so nicely drawn caused no little surprise, for it was of a difficult shape to harden, as will be seen by referring to Fig. 2. The punch had been ordered long, so as to provide for sufficient grinding. The blades *A*, which had been worked out from a solid piece of steel, were quite long and thin, and it became a matter of speculation as to how the punch had been hardened without bending or warping.

The more interesting feature of this punch became known when, after testing it with a file, it was found that the punch had not been hardened at all. It appears that the maker, having realized that the blades would warp, and having spent considerable time in making the punch, thought he would take a chance, so he polished the punch and drew it to a dark straw color, and incidentally lost his reputation. The stock to be punched would not permit the use of a soft punch, so it was necessary to make a new punch, the construction of which is shown in Fig. 3. The general design of this punch is somewhat similar to that shown in Fig. 2, except that the blades are made separate, and fastened to the main body of the punch. These blades are made 1/32 inch thicker than the finished size and then drilled, after which

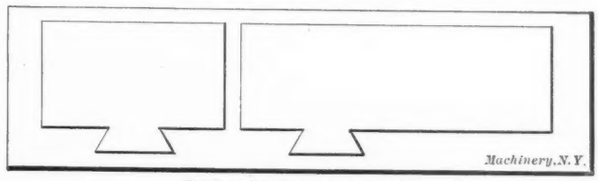


Fig. 1. The Pieces to be made

they are hardened and ground to the finished size. The blade *B* is inserted in a slot in the punch base, and the blade *F* is held to the side of the punch base.

In order to hold the blade *B* in place, two reinforced pieces *C* are fastened to the body of the punch by screws *D*, while screws *E* pass through these pieces, clamping the blade between them. The blade *F* is made to extend down past the punch base to the holder *G*, and is held in place by two pieces *H* and *I*; the piece *I* is located on top of the base of the punch, while the piece *H* is held to the base by a screw *J*, and two screws *K* passing through the blade hold piece *I* firmly to piece *H*. In this way the blade is held rigidly, as the pieces *H* and *I* are made long, thus supporting the blades. After repeated grinding, the pieces *C*, *H* and *I* can be taken off and ground down to the lines *L*, thus allowing the punch to be used to within ¾ inch of the base.

The die which is used for cutting out the pieces shown in Fig. 1, is shown in Fig. 4; an unusual feature of this die is that instead of the blanks being forced through the

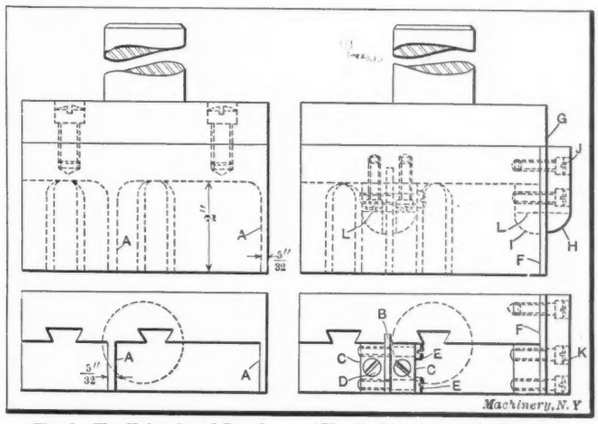


Fig. 2. The Unhardened Punch Fig. 3. The Successful Punch

die, the scrap is forced through instead. The die is set up in an inclined press, so that the blanks slide off the die into a box. In the illustration, *A* is the stripper-plate and *B* the stock, the latter being of the same width as the pieces shown in Fig. 1. The stripper *A* is attached to the die by three screws, as shown; a block *C* is also attached to the die-block by two screws, and acts as a guide for the strip. *D* is a stop for the stock, and *E* is a stationary guide, as the stripper at this point is cut away to allow the blanks to drop out. Spring pins *F* act as guides for the strip and are held in the die-bolster. These pins are formed with a shoulder, as shown, which rests against a stud *H*, screwed into the webs *I*. Pressing against the shoulders on the pins, are two coil springs *G*, which are held in the die-bolster by two screws *J*. These spring pins are forced down into the die as the punch

descends, and are returned by the springs *G* when the punch retreats.

The punch is made to overlap the stock; that is, it extends past the face *L* of the stock, so that it removes the burrs thrown up at the corners of the dovetails. As the stock does not vary in width to any extent, very few of the pieces would be shaved, and by having the punch fit in this way all objectionable burrs are removed. The outline of the punch is clearly shown in the lower view in Fig. 3. The reason for

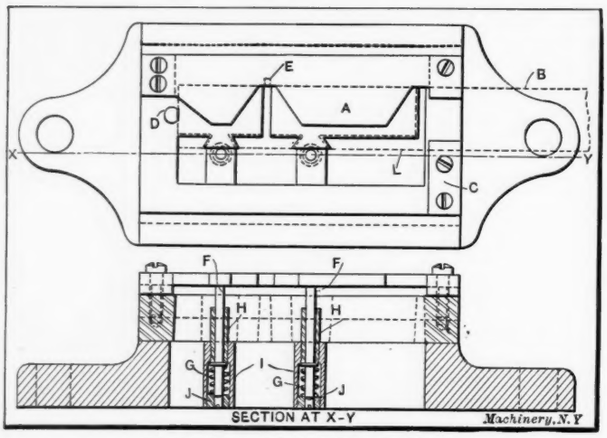


Fig. 4. Die used for Blanking the Pieces

making the die of this construction was merely to save material, there only being waste in the center and at the sides of the dovetail, as the strips were of stock size. This was found to be the most economical method of making these pieces.

Bayonne, N. J. J. A. LUTHER

HOOK-FLUTED TAPS

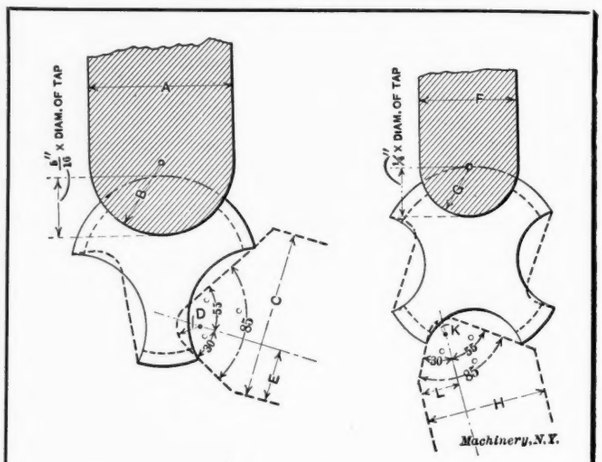
The advantage of the so-called "hook-flute" on taps is that it is possible with taps thus fluted to cut the threads in nuts with less power than otherwise, or in other words, the tap cuts with greater freedom. In the case of nuts made of steel of tough composition, taps fluted in this way are practically the only ones that will give satisfactory results. Hook-fluted taps have an under-cut cutting edge; that is they are provided with a positive rake. They are the very best taps to use for tapping steel and similar materials, but cannot be used to advantage for tapping brass, bronze, cast iron, and similar materials, as in this case a positive rake at the cutting edge is not permissible, a negative rake being, in fact, preferable. These general principles as applied to tap making are, of course, well known, but until recently very few taps have been made regularly for the market with a hook-flute.

In most cases the hook-flute on taps has been produced by using a convex cutter, as shown by the full lines in the engraving above the accompanying table. This kind of cutter is, however, not always satisfactory on account of the limited positive rake obtainable and the weak section of the lands of the tap that is a necessary consequence of its use. Taps fluted with cutters of this kind are more liable to break, but there are certain cases when the convex cutter must nevertheless be used, regardless of its disadvantages. When taps, for example, have to be backed out of a hole, the convex cutter is the best one to use for fluting them, because, on account of the form of the flute, the chips are not liable to get in between the teeth of the tap and the threads in the nut being tapped, when backing out. The difficulty due to chips getting in between the teeth of the tap and the threads in the nut, thus spoiling the thread and often breaking the tap, is frequently met with when a fluting cutter of the shape shown by the dotted lines in the engraving above the accompanying table, is used. This kind of fluting cutter, however, is the best one to use for fluting hook-fluted taps which will not have to be backed out, such, for example, as tapper taps. The tap is not weakened as much by a flute of this kind, and any amount of positive rake at the cutting edge can be obtained. This can be easily seen by studying the engraving.

An important point in favor of a cutter of the shape shown by the dotted lines is that it is much easier to keep sharp. It is nothing but an ordinary angular cutter which can always be sharpened by grinding the top of the teeth, and the required clearance can easily be obtained. The convex cutter, on the other hand, is almost always made of the formed eccentrically relieved type, and when sharpened is ground on the face of the teeth only. As these latter cutters, of necessity, have little or no clearance on the sides, they do not cut freely, but leave heavy burrs in the threads of the taps, which will break off when polishing the flutes after hardening and produce "ragged" teeth or cutting edges in the tap.

It might be said that convex cutters do not necessarily need to be made of the eccentrically relieved type, but that cutters of the regular milling cutter type might be used, the teeth of which can be ground on the top by means of special fixtures of a type similar to those described in MACHINERY, October, 1908. In that case any required clearance could be obtained on the top of the teeth. However, a cutter so made would have a very short life, as it would be reduced in width by the very first grinding, and would not apply for any length of time to the particular size of tap for which it had been made. It could, of course, be applied to smaller sizes.

TABLE OF TAP FLUTING CUTTERS

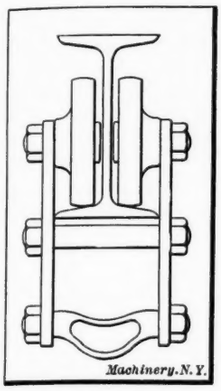


Diameter of Tap	Three Flutes					Four Flutes				
	Convex Fluting Cutter		Angular Fluting Cutter			Convex Fluting Cutter		Angular Fluting Cutter		
	Width A	Rad. B	Width C	Rad. D	From Side to Cent'r of Arc E	Width F	Rad. G	Width H	Rad. K	From Side to Cent'r of Arc L
$\frac{1}{8}$	$\frac{3}{32}$	$\frac{3}{64}$	$\frac{3}{32}$	$\frac{1}{64}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{3}{32}$	$\frac{1}{64}$	$\frac{1}{8}$
$\frac{1}{4}$	$\frac{3}{16}$	$\frac{3}{32}$	$\frac{1}{8}$	$\frac{1}{32}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{1}{32}$	$\frac{5}{32}$
$\frac{1}{2}$	$\frac{3}{8}$	$\frac{3}{16}$	$\frac{1}{2}$	$\frac{1}{16}$	$\frac{5}{32}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{2}$	$\frac{3}{64}$	$\frac{3}{32}$
$\frac{3}{4}$	$\frac{9}{16}$	$\frac{9}{32}$	$\frac{3}{4}$	$\frac{3}{32}$	$\frac{7}{32}$	$\frac{3}{8}$	$\frac{3}{16}$	$\frac{3}{4}$	$\frac{1}{16}$	$\frac{7}{32}$
1	$\frac{3}{4}$	$\frac{3}{8}$	1	$\frac{1}{8}$	$\frac{5}{16}$	$\frac{1}{2}$	$\frac{1}{4}$	1	$\frac{3}{32}$	$\frac{1}{4}$
$1\frac{1}{4}$	$\frac{15}{16}$	$\frac{15}{32}$	$1\frac{1}{4}$	$\frac{5}{32}$	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{5}{16}$	$1\frac{1}{4}$	$\frac{1}{8}$	$\frac{5}{16}$
$1\frac{1}{2}$	$1\frac{1}{8}$	$\frac{9}{16}$	$1\frac{1}{2}$	$\frac{3}{16}$	$\frac{7}{16}$	$\frac{3}{4}$	$\frac{3}{8}$	$1\frac{1}{2}$	$\frac{5}{32}$	$\frac{3}{8}$
$1\frac{3}{4}$	$1\frac{5}{16}$	$\frac{21}{32}$	$1\frac{3}{4}$	$\frac{7}{32}$	$\frac{9}{16}$	$\frac{7}{8}$	$\frac{7}{16}$	$1\frac{3}{4}$	$\frac{3}{16}$	$\frac{7}{16}$
2	$1\frac{1}{2}$	$\frac{3}{4}$	2	$\frac{1}{4}$	$\frac{9}{16}$	1	$\frac{1}{2}$	2	$\frac{7}{32}$	$\frac{1}{2}$
$2\frac{1}{4}$	$1\frac{11}{16}$	$\frac{27}{32}$	$2\frac{1}{4}$	$\frac{9}{32}$	$\frac{11}{16}$	$1\frac{1}{8}$	$\frac{9}{16}$	$2\frac{1}{4}$	$\frac{1}{4}$	$\frac{9}{16}$
$2\frac{1}{2}$	$1\frac{7}{8}$	$\frac{15}{16}$	$2\frac{1}{2}$	$\frac{5}{16}$	$\frac{3}{4}$	$1\frac{1}{4}$	$\frac{5}{8}$	$2\frac{1}{2}$	$\frac{9}{32}$	$\frac{5}{8}$
$2\frac{3}{4}$	$2\frac{1}{16}$	$1\frac{1}{32}$	$2\frac{3}{4}$	$\frac{11}{32}$	$\frac{13}{16}$	$1\frac{3}{8}$	$\frac{11}{16}$	$2\frac{3}{4}$	$\frac{5}{16}$	$\frac{11}{16}$
3	$2\frac{1}{4}$	$1\frac{1}{8}$	3	$\frac{3}{8}$	$\frac{7}{8}$	$1\frac{1}{2}$	$\frac{3}{4}$	3	$\frac{11}{32}$	$\frac{3}{4}$

The accompanying table gives dimensions for fluting cutters of both kinds for taps of varying diameters. The size of the hole in the cutter and the outside diameter are not given, as these dimensions must be made to conform to the machines in which the cutters are to be used. It will be noticed that when fluting with convex cutters the center line of the cutter coincides with the center line of the tap, whereas when angular cutters are used the point of the cutter is set off center. The table gives dimensions for both kinds of cutters for both three- and four-fluted taps. CORRESPONDENT

I-BEAM TROLLEY DESIGN

Referring to the article on I-beam trolley design which appeared in the January issue of MACHINERY, it seems to the writer that this is a question very similar to that of perpetual motion, for it is constantly appearing from time to time in all the mechanical papers, but no definite conclusions are arrived at. Your correspondent points out two objections to the first design with which the writer agrees.



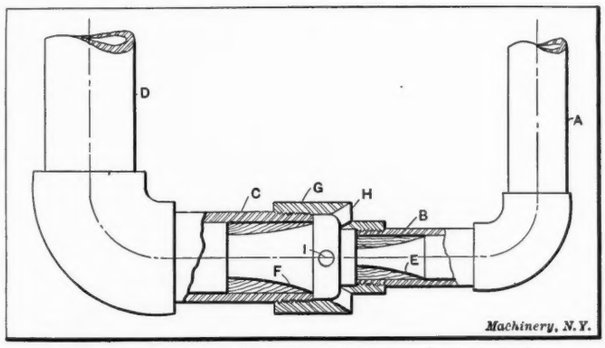
I-Beam Trolley of Practical Design

To overcome these defects a compromise is made, such as shown in the trolley design herewith illustrated. This engraving is self-explanatory. The writer has a great many of these in use which have been running for several years, and can confidently say that they operate very easily and require no attention whatever, with the exception of an occasional drop of oil. P. H.

A HOME-MADE SIPHON

A siphon of simple construction which can be easily and quickly made is shown in the accompanying illustration. This siphon is made entirely of pipe fittings. *A* is the feed pipe 1/2 inch in diameter; *B* is a nipple about 2 inches long made from ½-inch pipe; *C* is a 1-inch nipple about 2½ inches long; and *D* the discharge pipe 1 inch in diameter. Wooden plugs *E* and *F* are driven in the nipples *B* and *C*, respectively, and are flared as shown. The reducing coupling *G* is provided with seven ¼-inch holes *H*, equally spaced and drilled through the shoulder, all "meeting" at a common center. Seven additional ¼-inch holes *I* are bored through the circumference, equally spaced and are staggered in relation to the holes *H*, bored through the shoulder of the coupling.

In application, the siphon is lowered into the liquid, which is to be pumped out, and in pumping out a cellar a hole



A Home-made Siphon which can be cheaply and quickly made

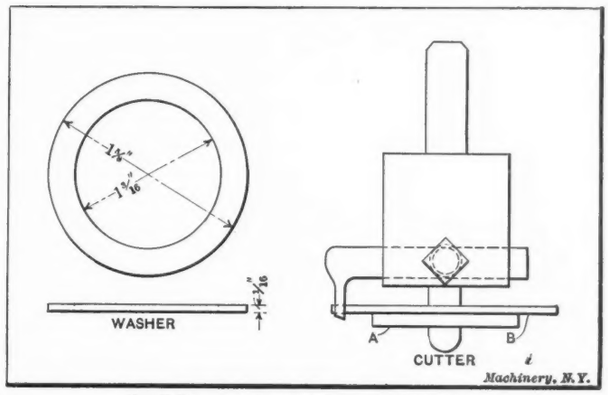
should be dug so that the siphon will be located deeper than the lowest surface of the water. Steam, air, or water may be used for power; this flows through the feed pipe *A* and produces a strong suction, drawing the water through the holes *H* and *I* and discharging it through the pipe *D*. The writer constructed such a siphon in about one hour's time, and pumped three inches of water out of a basement measuring 40 feet square in about five hours. The water was lifted about 6 feet, and water having a pressure of about 40 pounds per square inch was used as power for creating a suction.

Oaklyn, N. J. CHARLES R. ENGEL

CUTTER FOR SMALL FIBER WASHERS

The fiber washer cutter which is described in the following, and illustrated in the accompanying engraving, is a kink that will be appreciated by all those who have ever had occasion to cut a few washers. Recently, the writer was presented with the task of making several hundred fiber washers such as the one shown to the left in the illustration. The fiber was first cut into strips two inches wide, and then laid out, centered and drilled with a ¼-inch drill. The cutter was then set to a diameter of 1 3/16 inch to cut out the central opening of the washer.

After all the strips were put through these first operations, the more difficult task of cutting out the washer was presented. For this purpose, the washer *A*, 1 3/16 inch diameter and 3/32 inch thick was turned out of sheet brass, and soldered on the pilot in such a position that the cutter could only cut down half way through the fiber blank. One half was first cut, the blank turned over and the other half cut through. It was in this latter operation that difficulties were encountered, for the fiber, when nearly parted, had a ten-

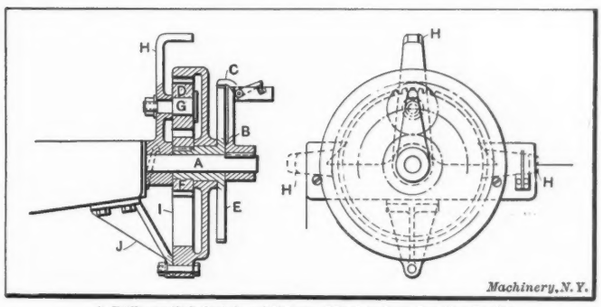


Small Fiber Washer and Cutter for Producing it

dency to tear, forming a ragged parting. This matter was corrected in a simple manner by soldering a brass disk *B* to the upper surface of the disk *A*. (Disk *B* is made 1½ inch in diameter so that the fiber washer can be removed while the cutter revolves.) This prevented the cutter digging in beyond the half-way limit, which was the cause of the tearing. By this method, the washers were turned out in good condition, leaving only a slight fin which could be readily removed with a sharp knife or a fine file. W. F. H.

A DIFFERENTIAL QUICK-WITHDRAW MECHANISM

The accompanying illustration shows a quick-withdraw device which can be attached to the lathe cross-slide when the construction of the cross-slide screw is such that it is impossible to move it bodily in a direction parallel with its axis. In the illustration, *A* is the cross-slide feed-screw, to which is keyed a handle *B*, fitted with a catch or finger *C*, which can be engaged in teeth cut in the index-plate *E*. This index-plate is not keyed to screw *A*, but rotates freely on it, and is keyed to the gear *F*, which, in turn, meshes with the gear *D* held on stud *G*. The stud *G*, on which gear *D* fits loosely, is held to



A Differential Quick-withdraw Mechanism for the Lathe

a handle *H* as shown, this handle rotating freely on the screw *A*. Gear *D* meshes with an internal gear *I*, the latter being held to the cross-slide by a bracket *J*.

When the tool-slide is to be adjusted, the catch *C* is released by a pressure of the hand, thus disengaging it from index-plate *E*. Screw *A* can now be rotated by means of the handle *B*, independently of the regular withdrawing mechanism. The setting for the depth of cut is facilitated by notches in plate *E*. While this device could be used in a number of cases for different classes of work, its chief value is for cutting screw threads, as it takes the place of the micrometer stop or collar

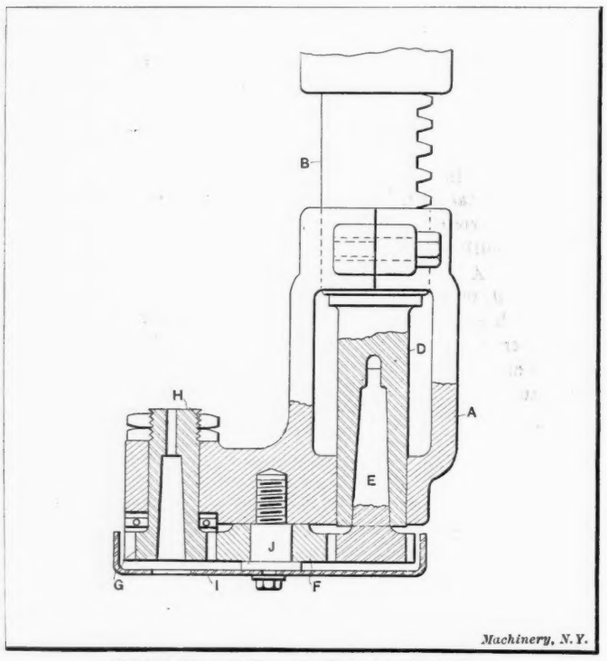
used on most lathes for this purpose. For the quick withdrawing of the tool-slide, handle *H* is turned one-half revolution into the positions shown by the dotted lines (in right-hand view), and as the internal gear *I* is stationary, the movement of the handle causes gear *D* to rotate, driving gear *F*, which is keyed to shaft *A*. Thus, by turning the handle *H* a quick motion is given to the feed-screw, withdrawing the tool from the work.

When catch *C* is in contact with plate *E*, and handle *B* is rotated, the index-plate *E* also rotates, but when the catch is disconnected, of course no motion will be imparted to plate *E*, handle *H* only being moved. It will thus be seen that the tool-slide can be withdrawn without changing the position of handle *B* and plate *E*, so that when *H* is revolved to its former position, the tool will then be in the same position that it previously occupied. By moving handle *B* relative to the notches in plate *E*, the threading tool can be set in to the depth required for the next cut. The internal gear *I* has 60 teeth and the gears *D* and *F* each have 20 teeth; therefore, one-half revolution of the handle *H* will revolve gear *F* twice, and consequently impart the same number of revolutions to the screw *A*. The pitch of screw *A* equals ½ inch, so that the tool is withdrawn 1 inch for one-half revolution of handle *H*.

X. Y.

OFFSET DRILLING ATTACHMENT

Having a considerable number of holes to drill under a projecting part of a piece of work, we designed the attachment shown in the accompanying illustration. This device consists of a cast-iron frame *A*, which is clamped to the sliding sleeve *B* of the drill press, while the lower end of the frame is bored out to receive the "live" spindle *D* of the drill press. A small gear with a shank *E* fits into the live spindle and meshes with an intermediate gear *F* held to the bracket. Gear *F* drives gear *G*, which is made integral with the vertical



Efficient Offset Drilling Attachment for Light Duty

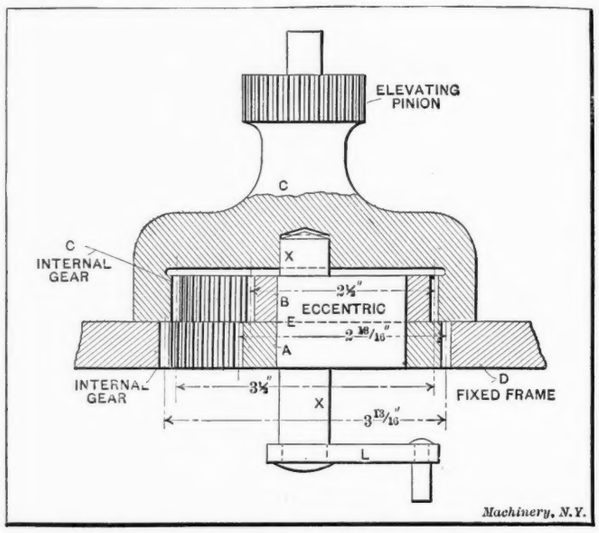
spindle *H*. A guard *I* is located on the stud *J* and protects the gears. This arrangement might not be applicable for heavy work, but for very light drilling, it has proved satisfactory.

W. A.

ANALYSIS OF SPEED-REDUCING MECHANISM

The analysis of a gear train is always an interesting problem, and in addition, it is instructive to a high degree; it develops the habits of inspection and thoroughness in a man. This is especially true because no one rule can be made to cover all cases; consequently, different problems offer different ideas and solutions. One of the nicest problems along this line that the writer has come across for some time is the finding of the speed ratio between the crank and elevating pinion in the mechanism shown in the accompanying engraving. This train is used as a sort of hand-operated elevator and the multiplication of power is considerable; the speed reduction is so great that the device is self-locking with any ordinary load—a requisite feature of an elevating system.

The construction of the mechanism is as follows: An eccentric *E* is driven by the crank *L* and is free to turn in the gears *A* and *B*, the stud *X* being free to turn in the casting *C*. The gear *A* meshes with the internal gear of the fixed frame *D* and is bolted to gear *B* which, in turn, meshes with the internal



Epicyclic Gear Train used in a Speed Reducing Mechanism

gear *C* which is an integral part of the elevating pinion. As the eccentric is turned by the crank *L*, gear *A* is moved around inside of *D* and carries *B* with it rolling inside of *C*. Since the diameter of *A* is a little more than that of *B*, *C* is revolved slowly in the same direction as *L*. *A* has 45 teeth, 16 pitch; *B*, 45 teeth, 18 pitch; *C*, 63 teeth, 18 pitch; and *D*, 61 teeth, 16 pitch.

The following analysis of the problem showing the speed ratio between *L* and *C* is perhaps the most satisfactory solution for such problems that has been devised. First consider all of the wheels locked together and imagine the entire combination as being turned to the right one turn. Then since the internal gear *D* is fixed it must be turned back one turn in order to bring it to its original position. While performing the last operation consider *E* as being held stationary and then calculate the total turns made by *C* during the entire proceeding; the result is the number of turns made by *C* for one turn of *E* or *L*. With *E* held stationary and *D* turned —1 times, *A* and *B* will each turn $-\frac{61}{45}$ times. *C* will make $-(\frac{61}{45} \times \frac{45}{63})$ turns in the same direction as *B*.

Tabulating the results obtained from these calculations gives the following number of revolutions and portions of revolutions for each of the gears:

	E	*A*	*B*	*C*	*D*
Wheels locked ..	$+1$	$+1$	$+1$	$+1$	$+1$
E stationary.....	0	$-\frac{61}{45}$	$-\frac{61}{45}$	$-(\frac{61}{45}\times\frac{45}{63})$	-1
	$+1$	$-\frac{16}{45}$	$-\frac{16}{45}$	$+\frac{2}{63}$	0

From the above, for one turn of the crank right-handed, *A* and *B* each make $\frac{16}{45}$ turns left-handed and *C* makes $\frac{2}{63}$ turns

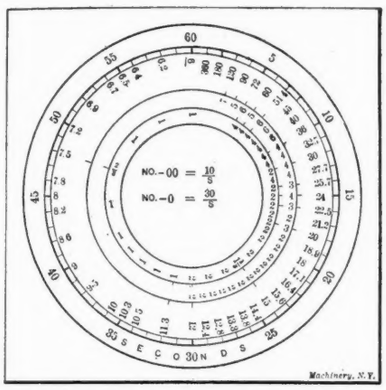
right-handed. The speed ratio is then $1:\frac{2}{63}$ or 31.5 : 1, that is, for 31.5 turns of L the elevating pinion makes one turn.

This method of analysis may be used with any gear train no matter how complicated, the chief requirement being to follow the combination through carefully, noting the result of turning each gear.

Scranton, Pa. S. HURLEY

A PRODUCTION CHART FOR SCREW MACHINES

The accompanying illustration shows a chart which the writer designed for screw machine use, but it can also be used in every department of the shop. This chart is of such a size that it can be cut out and placed in the back of a watch. Its purpose is to enable the foreman, speed boss or engineer, to calculate the number of parts made in ten hours, when the number of seconds required to make a piece is known, or *vice versa*.



Production Chart for Screw Machine Use

A few illustrations of the value of this chart may be of interest. First, in setting piece-work prices, when the day rate is known, the operator is timed, and the number of seconds required to make one piece is found; then the gross product for one day of ten hours will be found directly opposite the seconds on the chart. It is thus possible to figure the price per hundred without pencil and paper. The figures opposite the seconds represent the number of hundreds of pieces made, as, for instance, 19 seconds for one piece would be 1890 parts in ten hours. Without this chart it would be necessary to divide 19 seconds into 36,000, with the likelihood of making a mistake.

Again, suppose a foreman is placing a job on a machine, and in order to keep up with the factory output, he must obtain 1500 parts a day; he glances at his watch and sees that it will take 24 seconds to make one piece. What the writer wishes to make clear is that these problems come up many times during the day, and that the production of any machine can be determined by means of the watch alone. A screw machine foreman finds it very handy, because he can gear his machines up, on occasion, to hurry the parts through; this sometimes means more tool-cost but is often necessary. The reason all the productions are not given is that the chart was made for screw machine use, and the productions corresponding with the gears alone are given.

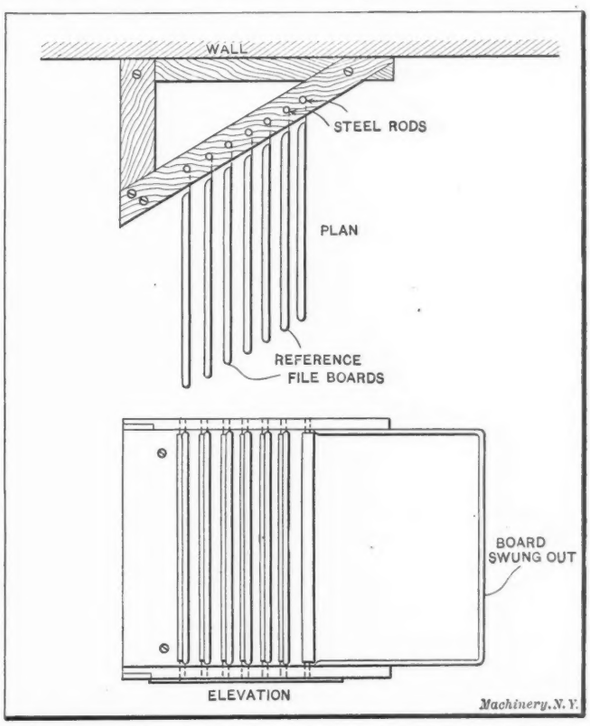
Another use is to tell instantly what gears to put on the screw machine to obtain the different productions. In the center of the dial is shown, for a No. 00 B. & S. automatic screw machine, the figures $\frac{10}{S}$; S is the seconds for one turn of the cam shaft (or for one piece), and 10 means that the driving shaft turns ten times as fast as the cam shaft, when the gears are one to one or $\frac{1\text{ driver}}{1\text{ driven}}$. Now opposite the number of seconds and inside of the production figures, are given the multipliers to obtain the gears which go with the machine. For example, what gears should be used for a 9-second job on the No. 00 B. & S. automatic screw machine? Opposite "9 seconds" will be found the multiplier 6, and $6 \text{ times } \frac{10}{S} = \frac{6}{6} \times \frac{10}{9} = \frac{60}{54}$, which is the number of teeth in the driver and driven gears.

The writer is aware that books and cards go with the machine, but all these tables can now be carried in your watch. It is very handy to pull out your watch any time, and note what gears are on a machine and what gears should be on. The method for the No. 0 B. & S. automatic screw machine is the same except that the ratio between the driving shaft and the cam shaft is $\frac{30}{1}$ instead of $\frac{10}{1}$; also the multipliers are on the inside row. The figures for the gears of the No. 2 B. & S. automatic screw machine are not given, as these gears are compounded, and this size of machine is not used so extensively as the smaller sizes. The operator of a few No. 2 B. & S. automatic screw machines will have his gears and speeds, etc., memorized, since the work is turned out much slower, some jobs running for weeks. S. N. BACON

WALL REFERENCE FILE

In shops and drafting-rooms where frequent reference to tables, charts and drawings of standard parts and machinery is necessary, some form of reference file should be provided. This should not only be readily accessible, but also simple and comprehensive.

A manufacturing company in the West has a system of hinged file boards, shown in the accompanying view, which is admirably adapted to this purpose. The boards are made of sheet metal, about 36 inches high by 24 inches wide and are hinged at the back to steel rods fastened to the wall. The edges of the boards are rolled over a ¼-inch steel rod to prevent their being bent out of shape. Blueprints, tables, drawings, etc., are pasted to the boards, the first board being used as an index to the rest. The file, when assembled, is similar to a book of data, and just as simple to use.



Wall Reference File, the Elevation showing One Sheet Open for Reference

Indianapolis, Ind. F. B. HAYS

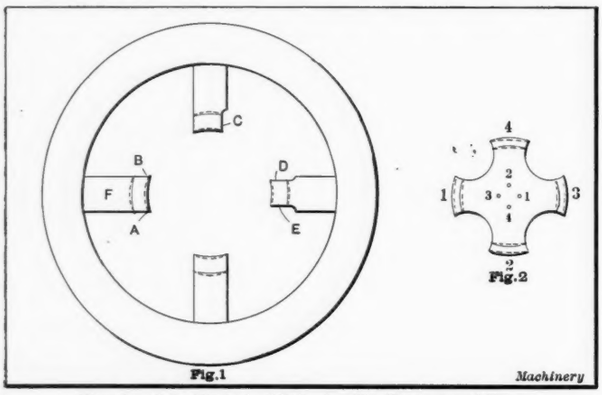
RELIEVING DIE CHASERS

Having read the article by Correspondent on "Relieving Die Chasers" in the July number of MACHINERY, it occurred to the writer that the following method which has given satisfactory results, although it is not used to any great extent,

might be of interest. The die chasers in this case are cut and relieved at the same time with a hob slightly smaller in diameter than the thread to be cut by the die. The chasers are cut by setting them to a diameter as much smaller than the thread to be cut as the hob is smaller than this thread. If, for any reason, the chasers cannot be adjusted in this manner, each chaser can be hobbed separately.

Chasers relieved in this manner bear as heavily on the screw being cut at the back edge *B* (see the accompanying illustration) as at the forward cutting edge *A*, except that the spring of the chaser under the strain of the cut tends to produce a slight relief at the back edge *B*. It is evident that the back edge will ride easily over the threads, and that it tends to steady the die. The result is an even and smooth thread.

In most cases a chaser such as shown at *F* works most satisfactorily, and if a thread must be backed out of the die it can



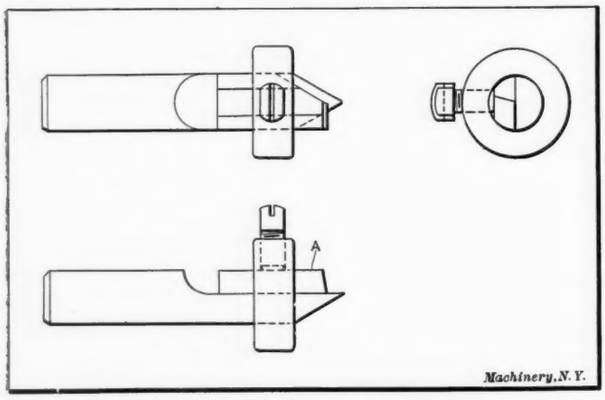
Figs. 1 and 2. Method of Relieving Die Chasers and Taps

be done without injury either to the chasers or the thread. If more relief than that provided for by the chaser *F* is required, the chaser can be ground away at the back as shown at *C*. When the chasers need to be sharpened, they should be ground on both edges as shown at *D* and *E*. The same principle of relief can be used with equally good results on taps, as indicated in Fig. 2. This relief can be produced on a lathe by the use of offset centers, but can also be very satisfactorily done by hand with a file. The same rules that govern the grinding of chasers apply also to the grinding of taps.

Watervliet, N. Y. MARTIN H. BALL

COMBINATION CENTERING REAMER AND FACING TOOL

A convenient combination countersinking and facing tool is shown in the accompanying illustration. The countersink is made in the customary manner, except that the half re-



Combination Centering Reamer and Facing Tool

moved is milled further back than usual. A piece *A* of the same stock is also milled down to half its diameter on one side, and the end shaped as shown, one corner being removed to clear the angle of the countersink and allow for chips, while the square face is backed off to form a cutting edge. This is securely clamped to the countersink by the set-screw in the encircling collar, and by the same means may be adjusted to give any desired depth of countersink. The advantage of facing the end lies in the superiority of the end-finish so that when the work is put in the lathe, it will run on true centers.

H. B.

DRILLING DIAMETRAL HOLES IN SHAFTS

There are various ways of drilling through round rods or shafts, but the device shown in Figs. 1 and 2 seems to have some merits peculiar to itself. It is made of two bars of rectangular steel *A* and *B*, preferably machined all over, but cold-rolled steel would do if the work is not too particular. The bar *A* is bored a slip fit for the hardened bushing *C*, of which there are several for drilling different sized holes. The hole in which the bushing fits must be exactly central with the V-notch in the bottom of *A*, and it must also be exactly central longitudinally in *A*, for reasons that will be referred to later. The bars *A* and *B* are held together by the two studs *D* and *E* running freely through *A*, screwed tightly into blind holes in *B*, and having hexagon nuts *F* and *G* bearing against the upper surface of *A*. The bars *A* and *B* are purposely left a little longer than would at first seem necessary; this is to afford an opportunity for applying calipers near the ends of the bars, to see if dimensions *H* and *K* are alike after the rod to be drilled is clamped in place. The bar *B* has a hole centrally through it a trifle larger than the largest hole in the set of bushings.

The reason for having the bushing longitudinally central in *A*, and also for having *A* exactly ½ inch thick, is to facilitate

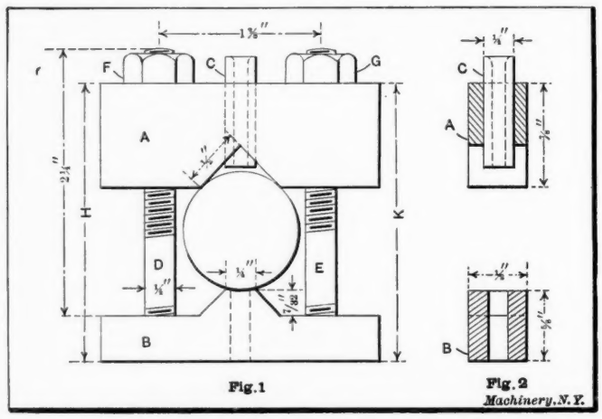


Fig. 1. Jig for Drilling Diametral Holes in Shafts

Fig. 2. Cross-section of Strap A

clamping the device in the proper location endwise of the shaft to bring the hole the right distance from the end, or from some shoulder on the shaft. Also, by having the outfit duplicated it is a comparatively easy matter to drill two diametral holes in the same shaft, where they are not less than ½ inch apart, and at the same time have the holes parallel by clamping both fixtures on the shaft at once. In case the two fixtures are clamped on different diameters of the same shaft, then a scrap piece of sheet metal is placed between the shaft and the lower bar of the fixture at the smaller diameter, the thickness of this piece being equal to half the difference of the diameters at the two points.

Mr. Chas. W. Spicer is the originator of this device, but he made his with a V-notch in the lower bar also. There seems to be no advantage in that; but if made with a V-projection on the lower bar as shown in Fig. 1, the range of sizes that the fixture will take is then somewhat increased. If made to the dimensions given, it will take round rods from 3/16 to 1 inch diameter, if the drill press chuck is of the Almond or Beach type, with jaws sliding on a taper; but if the chuck body is at all bulky near its lower end, there will not be room for it between the studs when drilling a small sized shaft, so the drill will then either have to be spliced out longer, or the studs *D* and *E* set further apart when making the fixture.

WALTER GRIBBEN

Brooklyn, New York.

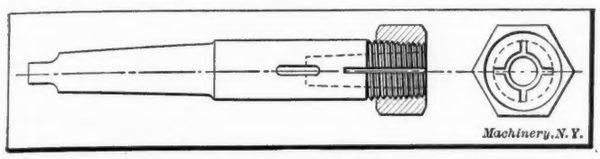
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

A DRILL SOCKET FOR HOLDING DRILLS WITH BROKEN TANGS

The accompanying illustration shows a socket for holding drills with broken tangs and also for protecting the tangs of good drills. This device can be made from an ordinary socket by slotting and threading the lower end as shown. A

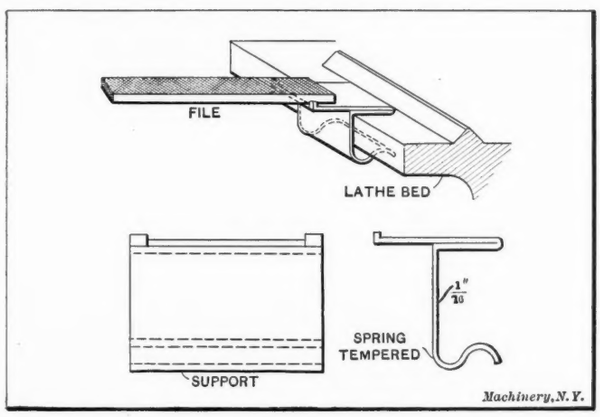


nut is then provided for tightening the socket on the drill shank. This device has been used by the writer for a considerable time and has proved satisfactory for holding drills with broken tangs as well as those in which the tangs were in good condition.

Eddystone, Pa. WILLIAM THOMAS

FILE SUPPORT FOR THE LATHE

When a machinist is filing at a lathe and the file clogs up, it is necessary for him to turn around and place the file on a bench to clean it. Sometimes the end of the file is rested on the lathe bed, but this is not advisable, as the filings get on the ways of the lathe where they are objectionable.

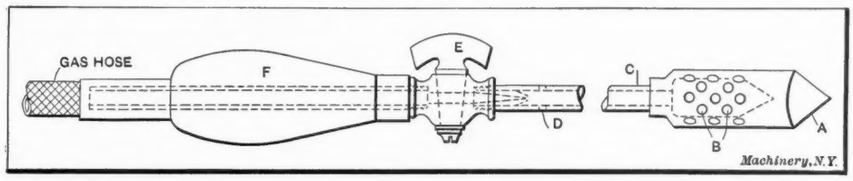


The small device shown in the accompanying illustration can be used for supporting the file when cleaning it. This consists of a piece of sheet steel 1/16 inch thick, which is bent into the shape shown, and made to fit snugly on the lathe bed. The lower part of this device should preferably be spring tempered, so that it will have a good grip on the lathe bed. In use it can be placed near the headstock where it is convenient and out of the way.

Hartford, Conn. JAMES E. COOLEY

A GAS-HEATED SOLDERING IRON

The accompanying illustration shows a soldering iron that will be found very useful for light bench work, for it can be



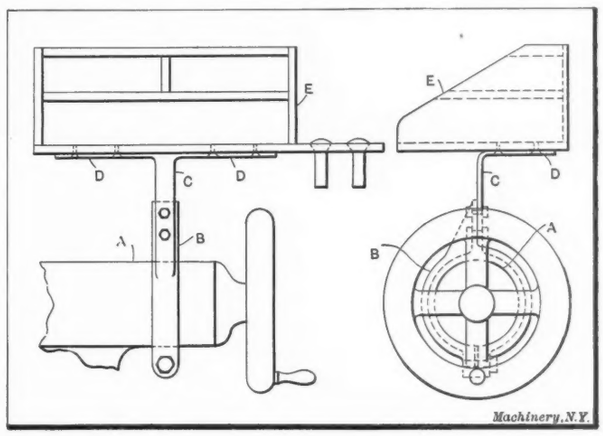
used continuously, doing away with the necessity of reheating or changing irons.

A hollow copper soldering butt *A* having a number of radial holes *B*, connects with a pipe *C* in which there is a Bunsen burner *D*. The gas is controlled by a pet-cock *E* attached to a wooden handle *F*, the gas hose communicating with this handle. It can be connected to any gas burner and will be found very useful on some classes of work. W. ALTON

TOOL SHELF FOR THE LATHE

It is quite common to see hammers, turning tools, files and other lathe tools placed on the end of the lathe bed. Sometimes the mechanic puts a flat piece of board on the lathe bed to hold the tools, but this frequently gets in the way and many mishaps occur, such as spilling the tools all over the floor, etc.

A simply made tool shelf is shown in the illustration which can be made and applied at small cost. The spindle of

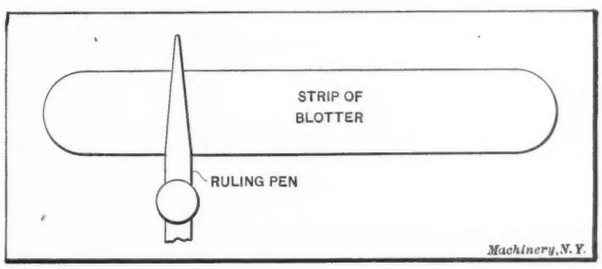


the tailstock *A* is encircled with a bronze or malleable iron casting *B* to which is attached a strip of iron *C*, this latter having the upper end bifurcated at *D*. A wooden box structure *E* is set on this, attached by wood screws. One side of this wooden box is extended to hold collets.

Woonsocket, R. I. KINGSTON FORBES

RULING PEN WIPER

Here is something that every draftsman will appreciate, for any one who does any tracing shares the pen-wiping rag troubles. In order to overcome the wiping rag trouble, the writer began to use the corners of a large blotter and finding it satisfactory in every way, made a farther step by cutting



a blotter into strips about ⅝-inch wide, the length being the width of the blotter, and rounding the corners off; this formed a neat little pen wiper. To wipe the ruling pen, push the blotter through the blades of the pen any distance and then pull it in the direction of the length of the blades, which action wipes the pen. The wiper can also be used for wiping writing pens, by simply moving its edge along the inside and outside of the pen. The writer has used these wipers for over two years; every one in our drawing-room now uses them, and finds them very satisfactory. They are always dry and ready for service. BENJ. BROWNSTEIN

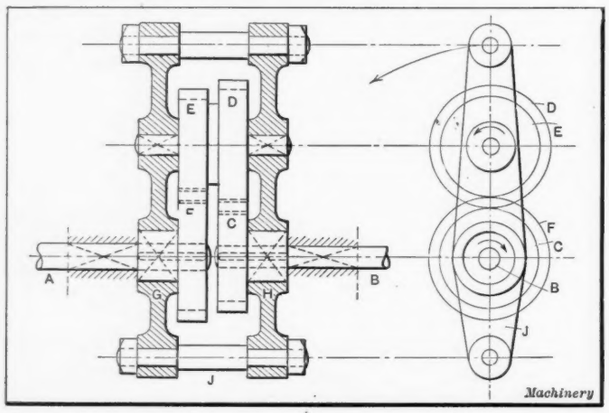
HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

PLANETARY GEAR DESIGN

O. S.—The illustration shows a train of gears between shafts *A* and *B*, of which pinion *C* is fixed on shaft *B*, gear *D* and pinion *E* are rigidly connected, and have their bearings in the pivoted frame *J* which consists of two parts *G* and *H* held together by distance bolts. The pivotal axis of the frame is coincident with the rotary axes of gears *C* and *F*. Gear *F* is fixed to shaft *A*. Now suppose that pinion *C* has 25 teeth, gear *D*, 30 teeth, pinion *E*, 25 teeth, and gear *F*, 30 teeth. The consequent relative movement of pinion *C* and gear *F* will be as 1 to 0.694. If now, for example, gear *F* is held stationary and power is applied to shaft *B* in the direction of the arrow, I assume that the frame will swing in a planetary manner in



the opposite direction, as indicated. For the demonstration of motion I made a crude model similar to that shown in the illustration, but did not get the anticipated result. Will you kindly tell me through the How and Why columns of MACHINERY what the trouble is?

A.—The reaction of the frame *J*, as you assumed, is in a counter-clockwise direction when the shaft *B* is turned in a clockwise direction. The reason you did not get a satisfactory action probably is due to crudeness of the apparatus. Planetary gearing as ordinarily designed, offers high frictional resistance. It must be made with accurately cut teeth and well-fitted bearings in order to secure a satisfactory action. The ratio of motion of the driver to the driven shaft should be generally higher than in this case to avoid excessive frictional resistance which may be greater than the driving force on the frame. With low ratios the gears lock, that is, the friction of the teeth and bearings is greater than the driving force.

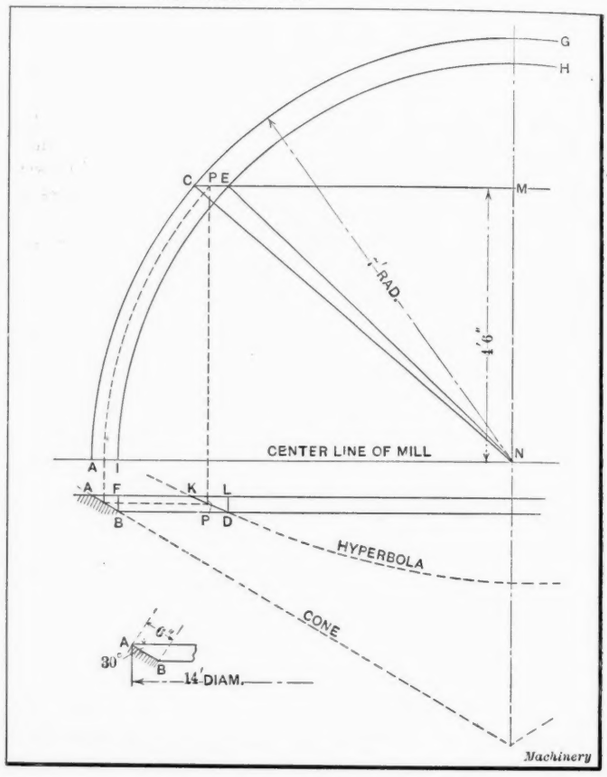
BORING LARGE BEVEL RING ON SMALL MILL

O. G. S.—A large ring, 14 feet 6 inches in diameter, for a blast furnace top, is to be bored out with a taper of 30 degrees over a surface 6 inches wide, as indicated in the lower left-hand corner of the accompanying illustration, the diameter of the ring at the point *A* being 14 feet. The only machine available for this job is a 10-foot Betts boring mill, and on account of the table being too small, strips have to be bolted onto it to support the ring. This necessitates that the housing be set back, which brings the tool 4 feet 6 inches back from the center line of the mill. The extension head cannot be used, so it is necessary to use the heads on the cross-rail. At what angle must the head be set in this location in order to give the 30-degree bevel?

A.—The answer to the question above may be obtained either by careful graphical construction or by a simple calculation. It should be noted, however, that feeding the tool in a straight line under the conditions given will not produce a perfectly straight beveled surface, but one that is slightly convex; the inaccuracy in this case is very slight, however, as can be shown by a simple graphical construction.

Draw, preferably to large scale, a sectional view and plan of the bevel ring, as shown in the illustration. Line *CE* shows the path of the tool projected on the horizontal plane. Points *C* and *E* projected to *K* and *D* give line *KD*, which is the path of the tool in the vertical plane. Angle *DKL*, therefore, is the angle to which the head should be set. This angle can be measured by a protractor, if the drawing has been carefully made. It will, in the given case, be found to equal 23 degrees, 30 minutes.

In order to ascertain if the line *KD* corresponds fairly well with the hyperbola along which the tool should properly be fed in order to produce a perfectly straight face at *AB*, construct the curve which forms the intersection between plane *CM* and the cone of which beveled face *AB* is a part. The construction of the intersecting curve, which is one of the problems found in practically all text-books on mechanical drawing, is accomplished by projecting points *P* from the plan view to the sectional view as indicated. It will be found that



in the present case the hyperbola almost exactly coincides with the straight line between points *D* and *K*. Hence, the inaccuracy produced, that is, the convexity of face *AB* will be very slight.

To calculate angle *DKL*, proceed as follows: First find the length of *CM*.

$\sqrt{CN^2 - NM^2} = CM$. Hence, $CM = \sqrt{84^2 - 54^2} = 64.343$ inches.

Next find length of *EN* and of *EM*.

$EN = CN - AF = 84 - 6 \times \cos 30 \text{ deg.} = 78.804$ inches.

$EM = \sqrt{EN^2 - NM^2} = \sqrt{78.804^2 - 54^2} = 57.392$ inches.

Then, $CE = CM - EM = 6.951 = KL$.

$KL \div LD = \cot DKL$.

But $LD = AB \times \sin 30 \text{ deg.} = 3$ inches.

Hence, $\cot DKL = 6.951 \div 3 = 2.317$, and $DKL = 23$ degrees, 21 minutes. Apparently, the graphical solution, 23½ degrees, is close enough for all practical purposes.

* * *

A party of members of the Society of Automobile Engineers will make a trip to Europe, leaving New York November 1. The first few days in England will be spent in examining the exhibits of the automobile show which will then be in progress at Olympia, London. They will be entertained by the Incorporated Institution of Automobile Engineers, which is the English society corresponding to the S. A. E. A trip will be made to Birmingham, and some of the interesting country in the Warwickshire district, Stratford-on-Avon, and surrounding territory will be passed through. The Humber automobile factory, one of the largest in England, will also be visited, as well as a large number of other plants, the plan being to see the best factories and inspect them thoroughly.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

LANGELIER HAMMERING MACHINE WITH PNEUMATIC ATTACHMENT

The Langelier Mfg. Co., of Providence, R. I., which has made a specialty of building hammering and swaging machines, recently added to its standard line the heavy No. 4 hammering machine shown in Figs. 1, 2 and 4. This design

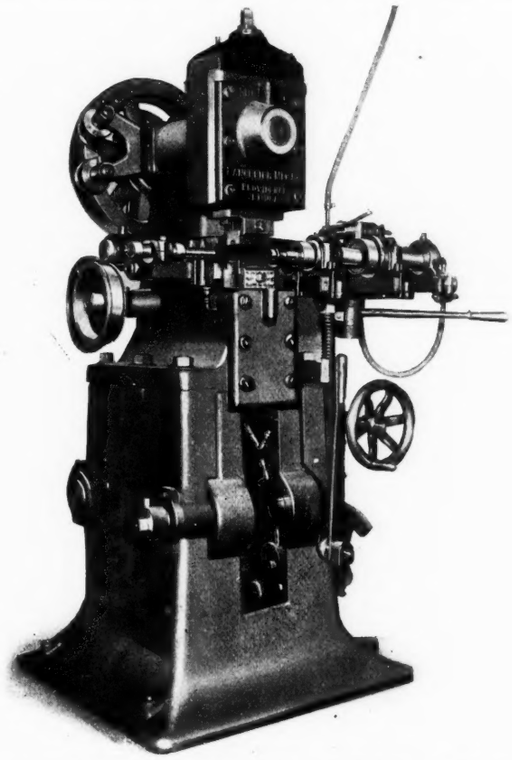


Fig. 1. No. 4 Heavy Hammering Machine, built by Langelier Mfg. Co.

is equipped with a special rotary attachment having an automatic, pneumatically operated chuck for handling work similar to that illustrated in Fig. 3. This machine uses blanks that have been previously reduced and formed by a swaging machine as shown at *A*. A power press with suitable tools is then used, in this particular case, to square the shoulder, as indicated at *B*, after which the pieces are finished to the shape shown at *C* in the hammering machine. The output of this machine is six hammered pieces per minute, and the work is finished accurately within a limit of 0.0015 inch in diameter. In addition to reducing pieces of the shape illustrated, this machine can be used for making a great variety of other forms out of hollow stock.

Figs. 1 and 2 give a very good idea of the general construction of the machine and show the pneumatic rotary attachment and also the main driving mechanism. The column of the machine is formed by a heavy casting of square cross-section, upon which is mounted a head containing the main spindle, spindle rolls and upper vertical plunger. The main drive is mounted at the side of the base, which encloses the lower vertical plunger with its operating mechanism. The spindle is driven from an overhead countershaft by a belt which leads to a pulley at the rear. The spindle carries a heavy balance-wheel, which insures smooth operation and absorbs the vibration of the hammer blows.

The pulley for driving the pneumatic rotary attachment is mounted on the left at the rear, as shown in Fig. 1. This pulley drives a horizontal shaft extending across to the opposite side where connection is made with the attachment through a chain and sprocket drive, as shown in Fig. 2. The spindle rolls which operate the upper vertical plunger and upper die are located at the front. Twelve blows are struck for every revolution of the main spindle, and as the latter makes 325 revolutions per minute, it will be seen that the blank receives 3900 blows per minute. The intensity of the blow is controlled by adjusting a screw on the head.

The lower die, which is the moving die, is mounted in a holder on top of the lower plunger. This plunger works vertically between two members of the head which extends down inside of the base at the front of the machine. The reciprocating motion of the plunger is imparted by a powerful toggle lever, fulcrumed on a trunnion shaft that is laid in the hanging members just referred to, and is actuated by a large wiper face cam at the rear of the base. This cam receives its motion from the main driving shaft through the spur and worm gearing shown in Fig. 2. As the wiper cam revolves, it alternately raises and depresses the toggle lever arm, thus simultaneously lifting and lowering the plunger and bottom die, which is gradually brought into contact with the upper die. The dies remain in contact a sufficient time to finish the work uniformly, after which the lower plunger is quickly returned. The trunnion shaft bearing cap of the toggle lever is extended into a fork-shaped journal, which may be seen in Fig. 1 through the opening in the base. This forked journal is connected with a crank lever keyed to a shaft which extends through the side of the base and carries at its outer end a segment cam which may be

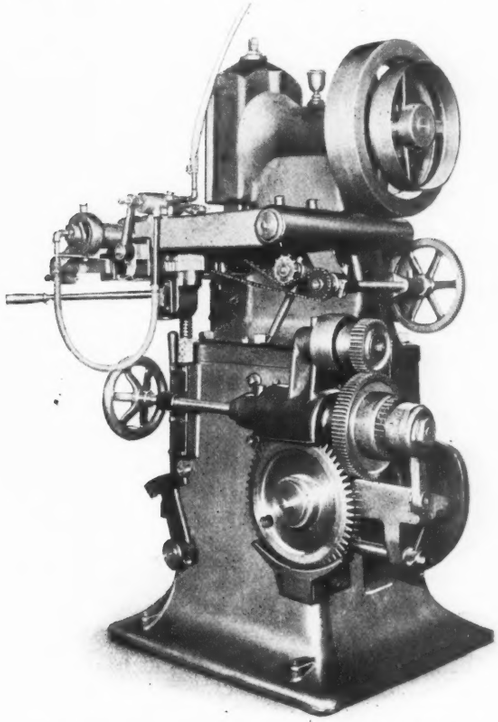


Fig. 2. View showing Main Driving Mechanism and Drive for Rotary Attachment

seen in Fig. 2. In this way a rocking motion is given to the segment cam which transmits the movement, by means of a roller and vertical slide, to the pneumatic attachment. This alternate raising and lowering of the attachment is absolutely necessary in order to keep the work central with the dies at all times until the hammering operation is completed.

The attachment consists essentially of a U-shaped casting, oscillating on a shaft at the rear of the head and having arms which straddle the head and extend to the front of the machine. The left arm carries a work arbor which fits into the tubing to retain its size and support the walls and thus prevent crimping under the hammer blows. The right arm

of the attachment carries the chain-driven pneumatic chuck which holds the work. Special air cylinders for opening and closing the chuck and for feeding and withdrawing the chuck pistons are also mounted on this arm. The reason for revolving the chuck and work during the hammering operation is to insure shaping the blank concentrically.

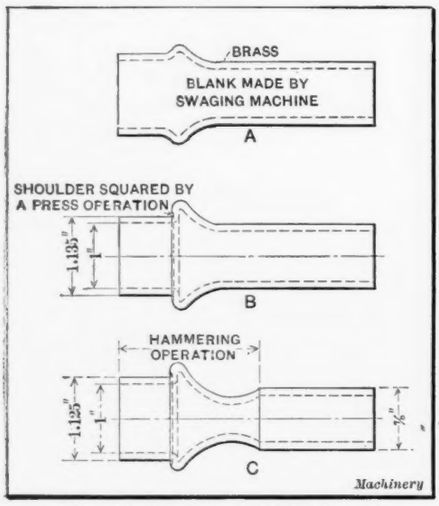


Fig. 3. Typical Example of Work done in Hammering Machine

All the functions of the air cylinders are controlled by a simple movement of the lever seen to the right of the machine. When this lever is moved to the rear, the air pressure releases the chuck jaws and the air exhausts into the atmosphere. The chuck is closed by air in such a way as to hold the work tight while the hammering is in progress.

The operation of the machine is uninterrupted between the ejection of the finished pieces and the insertion of a new blank. The main driving pulley revolves continuously, and the cam at the rear is arranged to trip a ratchet pawl at every revolution, thus stopping a roll clutch. As soon as the operator has inserted a new blank in the chuck, he releases

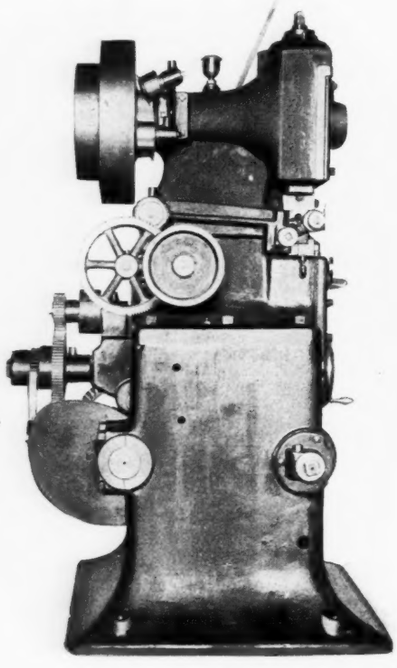


Fig. 4. Side View of Langelier Hammering Machine

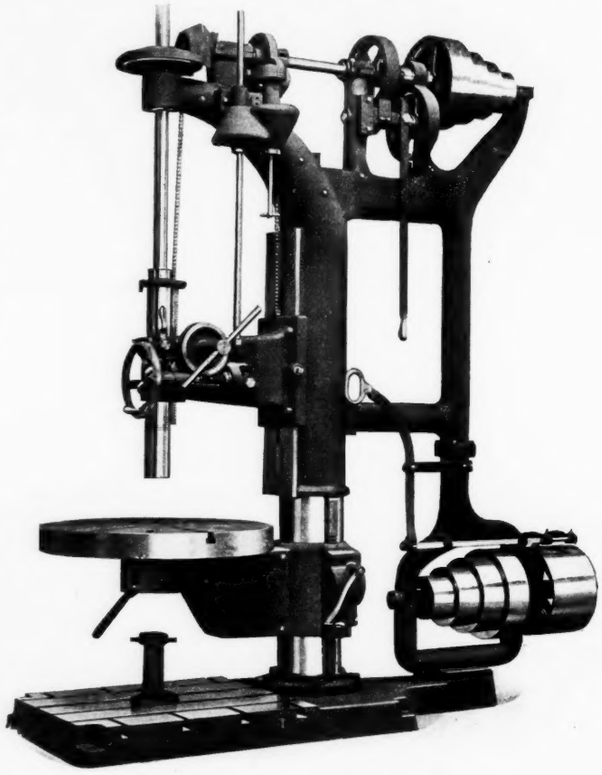
the clutch by a slight movement of the starting lever at the front of the machine, and the hammering proceeds. This machine weighs approximately 5900 pounds.

SNYDER HEAVY-PATTERN UPRIGHT DRILL

The accompanying illustration shows a large 46-inch upright drill built by J. E. Snyder & Son, Worcester, Mass. This is said to be the heaviest 46-inch drill made in this country. It weighs, skidded for shipment, 6400 pounds, and has an over-all height from the floor to the top of the upper cone of 9 feet, 10 inches. The main column, which is strongly braced and very rigid, weighs 1100 pounds and is 11 inches in diameter. The base weighs 1300 pounds and is strongly ribbed underneath.

The spindle is made of crucible steel and it has a bearing in the sleeve 2½ inches in diameter. The nose of the spindle is 4 inches in diameter and the lower end is equipped with a ball bearing. The table is 37 inches in diameter and has a 12-inch bearing in the arm. The greatest distance from the spindle to the table is 37½ inches and from the spindle to the base, 59½ inches. The head has a traverse on the column of 25½ inches, and the table arm has a vertical adjustment of 14 inches. The vertical feed of the spindle is 18 inches, and suitable graduations are provided, thus giving direct measurements.

There are five changes of geared feed, ranging from 0.007 to 0.052 inch per revolution of the spindle. This machine will



Snyder 46-inch Heavy Upright Drilling Machine

drill to the center of a circle 46¾ inches in diameter. The base is 84 inches long, 34½ inches wide, and 5½ inches deep. The head has a 10- by 18-inch bearing on the column, and the table-arm bearing is 15 inches. All gears are guarded, as the illustration shows, and the machine can be equipped with a tapping attachment if desired. Manning, Maxwell & Moore, Inc., are the selling agents.

GEOMETRIC SELF-OPENING AND ADJUSTABLE DIE-HEAD

The Geometric Tool Co., New Haven, Conn., is now manufacturing a new type of automatic opening die, which is shown in Fig. 1 and in detail in Fig. 2. This die, which is known as the "style DD," is especially designed for use in the turret of Cleveland automatic screw machines, but it can also be employed on other automatic or semi-automatic machines, the operation of which is similar to the make referred to. It is made regularly in 5/16, 9/16, 3/4, 1 and 1 1/4-inch sizes, the dimensions representing the maximum diameter of thread which each die-head is designed to cut.

The construction of this die is clearly shown in Fig. 2.

The dies are held at one side of the opening in which they are closely fitted, by splines of liberal size, and their position with relation to the diameter of the thread to be cut is controlled by cams *C*, engaging slots in the inner faces of the dies. As all four dies are adjusted simultaneously and are solidly supported as close as possible to the cutting strains, they cannot move away from the work and a high degree of accuracy is insured. The die-head is not held rigidly, as in the case of a solid die, but is supported by a spring

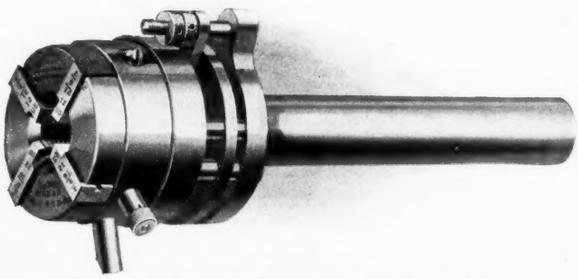


Fig. 1. Geometric Style DD Automatic Opening Die-head

mechanism *S* between the head and shank, which permits the chasers to compensate for any inaccuracy of turret adjustment. In other words, the head yields as it comes into contact with the work, thus allowing the chasers to adjust themselves. This feature also provides a certain amount of longitudinal movement independent of the turret feed, which allows the chasers to compensate, automatically, for any slight

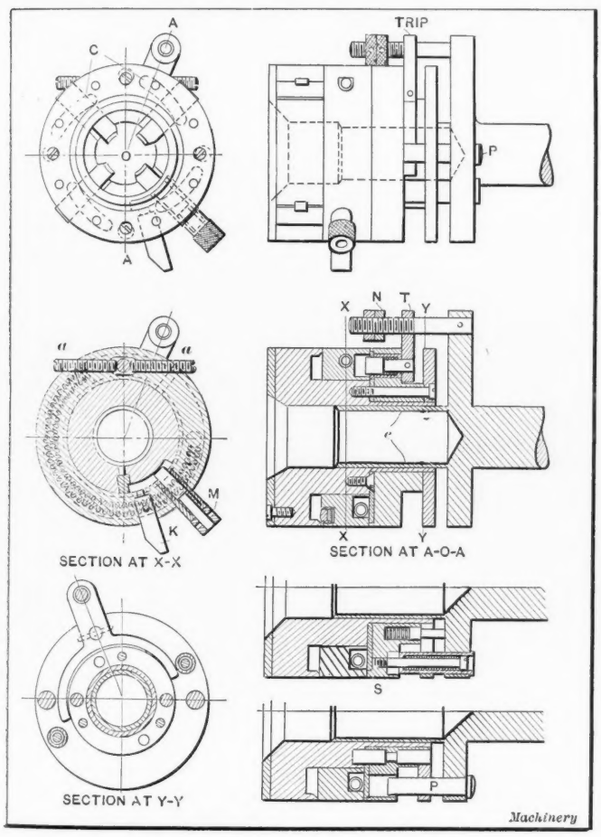


Fig. 2. Detail Views of Geometric Die-head

irregularities that may exist, thus insuring a product of uniform accuracy, and eliminating "wasters." The die-head is not mounted directly on the shank but is carried on heavy driving pins *P*, set into a substantial flange which is integral with the shank. Additional support is provided by the central extension *e* of the shank, on which the die-head is free to move.

The travel of the turret determines the length of thread to be cut, but this may be set to closer limits by means of the lock-nut adjustment *N* at the side of the die-head. When the turret reaches the limit of its travel, the die-head has a slight independent forward movement which causes the lock-nuts to contact with the hinged trip-plate *T*, thus releasing the locking bolt and opening the chasers. By adjusting these lock-nuts, more or less longitudinal movement can be obtained as required by the work. Fig. 3 shows the position of the die after completing a thread and just before the tripping mechanism opens the chasers, preparatory to moving back off the work.

A micrometer adjustment, controlled by two accurately fitted screws *a*, is provided at one side of the head, so that quick and accurate variations can be made in the diameter of the threads for a tight- or loose-fitting screw, as desired. The die-head is equipped with a closing pin *K*, which is used to close the chasers automatically by the rotation of the turret

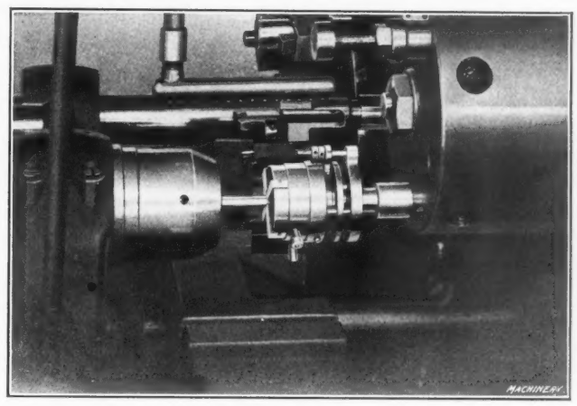


Fig. 3. Position of Die just prior to Operation of Tripping Mechanism

in connection with a closing bar attached to the turret housing, as indicated in Fig. 4, which shows the position of the die-head just prior to the closing of the chasers by the stationary bar. Owing to the great variation in size of the machines on which these tools can be employed, the closing bar is not included in the equipment.

Should it be desired to remove the chasers when the die-head is in the turret, they are first placed in the open position.

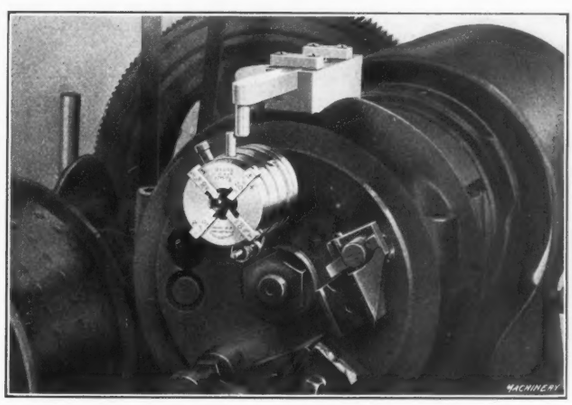


Fig. 4. Closing Pin on Die-head in Engagement with Stationary Pin which closes Chasers

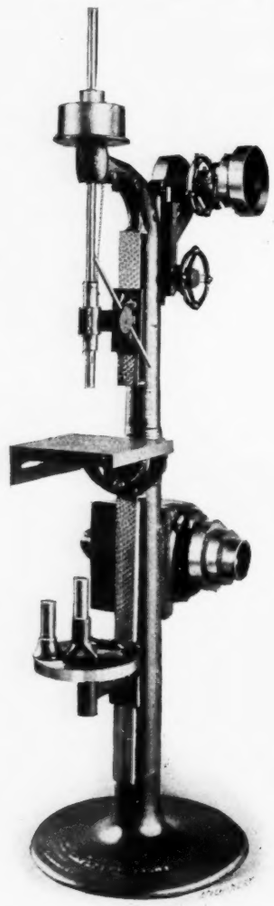
The spring plunger *M* is then withdrawn, which allows cams *C* to rotate sufficiently to release the chasers which are readily lifted out of place. After the chasers have been removed, the cam should be rotated back to its original position, which allows the plunger to drop into place. When the die-head is not in the machine, the chasers are removed by gripping the shank in a vise and turning the head to open the chasers. When replacing the chasers, care should be taken to see that the numbers stamped on them correspond with the numbers on the housings, so that they will "track," or lead, properly.

While the style DD die-head is made regularly in only five sizes, as previously stated, larger sizes of either the regular or a special construction can be furnished.

MOTOR-DRIVEN SENSITIVE DRILL PRESS

A new type of motor-driven sensitive drill press has recently been placed on the market by the Washburn Shops of the Worcester Polytechnic Institute. Among the noteworthy features are the method of attaching the motor, and the ease with which the belt tension can be varied. As will be seen from the illustration, the motor is mounted at the rear of the column, thus balancing the tables at the front and giving a symmetrical effect to the whole machine.

The motor is attached to a baseplate bolted to the column, and the drive is from the cone on the motor to a cone on the drive shaft and then by a quarter-turn belt to the spindle. The tensions on these belts are controlled by automatically locked belt tighteners. The bearing for the drive shaft is made to slide in and out on a bracket, while the bracket itself has a vertical movement through a gibbed slide on the column, both motions being controlled by the handwheels, working through rack and pinion movements. Attached to and forming a part of the pinion shaft, is an automatic locking device. This locking device is so arranged that the bracket and slide is locked in every position, and the belt tension is varied by simply turning the handwheel. This device is very simple and does not get out of order, as the same arrangement has been used by the Washburn Shops on hundreds of drawing stands and drafting tables during the past few years without a single defect. With this arrangement it is possible to tighten the belt to the exact tension necessary for the best results, and it is so easily operated that, on completing a job, the tension of the belt can be instantly released, thus increasing the life of the belt.



Washburn 14 inch Sensitive Drill Press

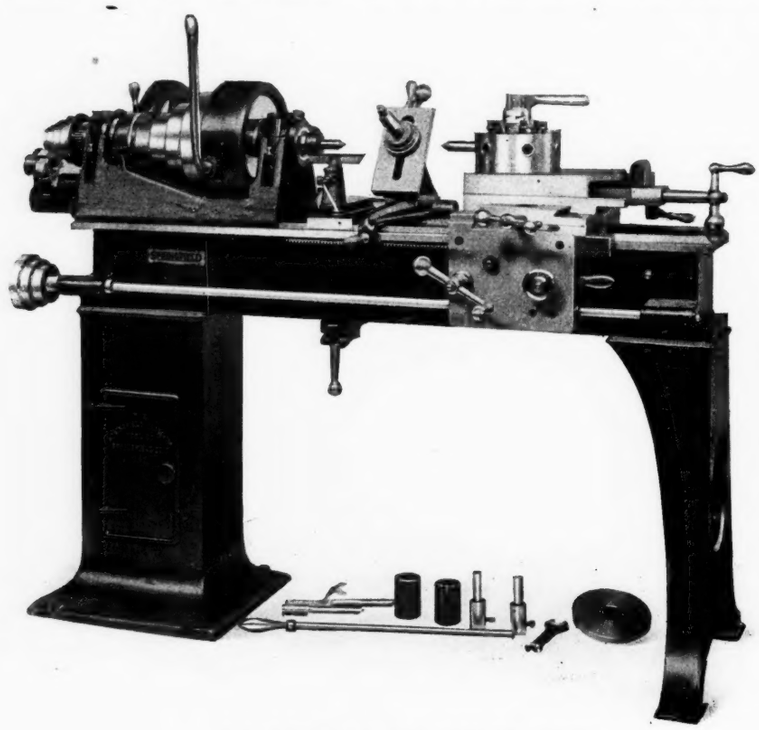
Both the motor shaft and drive shaft have ring-oiling bearings. The spindle pulley is supported on an independent bearing which takes the entire pull of the belt so that the spindle runs absolutely free. The bearing on which the spindle pulley runs is always flooded with oil, a retaining ring being cast concentric with the bearing which forms a basin for holding the oil and prevents all spatter.

The 14-inch drill has both a square and a round table as shown. The square table swings about the column and it can also be tipped to any angle. The round table is vertically adjustable on the column, and can be removed and either a cup center or a crotch center placed in the supporting bracket. These centers are both furnished with the machine. The 13-inch drill is of similar construction, but has only the square table. The square table is supported by a slide which runs the whole length of the column, the head bracket being on the same slide.

Both machines have a capacity up to 9/16 inch diameter. The spindle speeds are 644, 1130 and 1976 revolutions per minute. Any type of induction or direct-current motor can be used, but to give the speeds mentioned, with the regular cone arrangement, the speed of the motor should be 1130 revolutions per minute. This machine, equipped with a constant-speed motor, weighs 430 pounds.

SPRINGFIELD BRASS-WORKING TURRET LATHE

A brass-finishers' turret lathe that is a recent design of the Springfield Machine Tool Co., 631 Southern Ave., Springfield, O., is illustrated herewith. This is a 15-inch by 5-foot machine of the cabinet type, and is equipped with a friction-geared head. The turret is provided with a new clutch mechanism which is an improvement on the old style in that it enables the turret to be handled more quickly.



Springfield 15-inch by 5-foot Cabinet Turret Lathe

The turret is designed so that a slight backward movement of the operating lever loosens it and at the same time withdraws the locking pin, while a slight forward movement indexes the turret, bringing the next tool into the working position, and at the same time locks and tightens the turret. This entire operation is performed with one hand and in a very short time. The turret has a power feed, having three changes, and its movement can be reversed by a handle at the side of the apron. There is also a longitudinal movement by either a lever or screw. The top turret slide rests upon a slide having a right-angle hand movement, operated by a screw at the front, which gives a large range for facing work held in the chuck. After using this hand cross-feed, the holes in the turret can always be brought central with the spindle by a positive stop, which can be quickly removed when tools are to be used back of the spindle center.

The slide has an additional cross-movement operated by a

supplementary taper slide, the taper being derived from a bar between the ways of the bed, which is set by a graduated index to obtain any taper up to 4 inches per foot. This taper attachment makes it unnecessary to set over the headstock for taper boring or turning, and it also enables a part to be faced square after the taper work is completed, without any change. When used for straight work, the taper slide is locked to the saddle by a tapering tool-steel pin, having a square head to facilitate its removal.

Different pitches of thread are obtained in this machine by the well-known follower and leader device. One leader and follower for cutting 11½ threads per inch, and also one hob for cutting the follower, are furnished with each lathe. This machine is so arranged that left-hand threads may be cut with right-hand leaders, thus making it unnecessary to have a special set of left-hand hobs and leaders. Straight or tapering threads can be cut, and the change from one to the other may be quickly made. Inside boring and tapping can also be done while forming outside taper work. The front bearing of the chasing bar can be moved along the bed by means of a tongue and groove, in order to provide for changes in the chasing head when operating on work held in the chuck or between centers.

As the engraving shows, the lathe has one cabinet leg into which shelves can be fitted for the reception of tools, chucks, etc. The headstock has a four-step cone of large diameter, and is provided with back-gears having a ratio of 8 to 1. The spindle is of high-grade steel, accurately ground, and has a 1-inch hole through it. The journals are of phosphor-bronze. The diameter of the turret is 7½ inches, the length of the carriage, 12 inches; the movement of the top slide, 5¼ inches; the cross-movement of the top slide, 6¼ inches; and the maximum distance between the headstock center and turret, with a 5-foot bed, 23 inches.

SUPERIOR TOOL-HOLDERS

The tool-holders shown herewith combine strength with resiliency owing to the gun spring or "goose-neck" construction. These tool-holders are drop-forged from steel and are accurately machined and casehardened. The cut-off tool, Fig.

Fig. 1. Superior "High-speed" Cut-off Tool

1, has high-speed steel blades which are beveled and ground and of a stock size. This holder is made in two sizes, known as Nos. 1 and 2. The first size has a ½- by 1⅛-inch shank and a ¾-inch blade, and the larger size has a ⅝- by 1¼-inch

Fig. 2. Superior "High-speed" Threading Tool

shank and ⅞-inch blade. The cutters for the thread tool, Fig. 2, are also made of high-speed steel. These cutters are furnished for either U. S. standard or V-threads. This type of holder is said to avoid all chatter and breaking of blades or cutters. The Superior Machine Tool Co., Kokomo, Ind., is the manufacturer.

NATIONAL AUTOMATIC DIE-HEAD

The die-head illustrated in Fig. 1 is an adjustable self-opening and self-closing type brought out by the National Tool Co., Cleveland, O. This die-head is designed for use on hand and automatic screw machines, for cutting threads of standard and special pitches or pipe threads of any size within its capacity.

Fig. 2 shows the various parts of the die-head. The chasers are mounted in carriers that slide in the grooved disk or block shown, which is contained in a shell screwed to the shank. Fitted over this shell and threaded to the latter, is a hardened and ground knurled adjusting ring that is tapering on the inside. Interposed between this ring and the chaser carriers there are hardened steel balls which are placed in holes drilled through the shell containing the die-block. The dies are adjusted for threads of various diameters by the

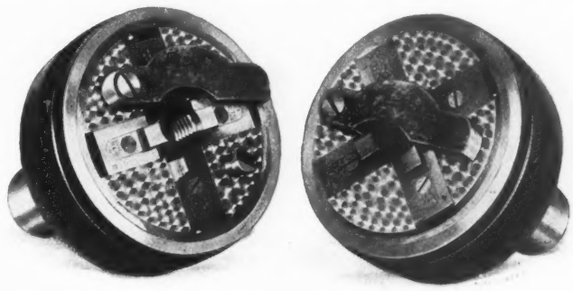


Fig. 1. National Automatic Die-head in the Closed and Open Positions

knurled ring referred to, the diameter of the thread being increased or diminished by turning this ring to the right or left with relation to a suitable graduation mark.

The die, which is mounted in the turret, is opened by stopping the travel of the turret slide. As soon as the turret comes to a stop, the inner die-block is drawn forward by the action of the thread which is being cut on the stock, and this movement of the die-block brings the recesses in the chaser carriers opposite the steel balls, and thus permits

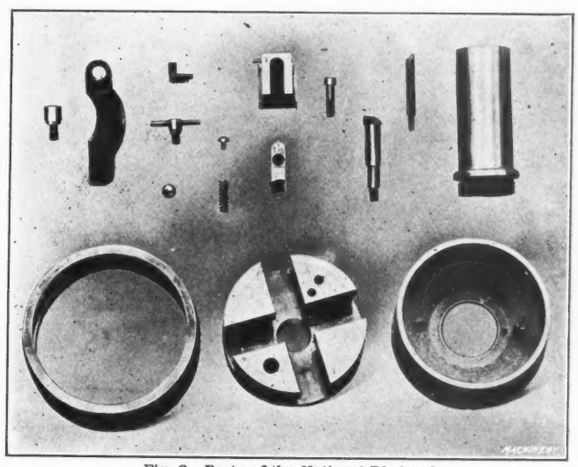


Fig. 2. Parts of the National Die-head

the chasers, which are under the tension of springs to open. The length of the thread is governed by setting the stop on the turret slide. The dies are closed by the latch shown attached to the die-block Fig. 1. This latch, when the dies are opened, extends across the center as shown to the right. The turret advances until this latch comes in contact with the end of the stock to be threaded, which forces the die-block and chasers back to the exact threading position, the dies being shifted inward by the hardened balls. During this backward movement of the die-block, and while the chasers are closing, the latch automatically swings upward out of the way as shown to the left in Fig. 1. From this, it will be seen that the die is entirely self-contained, no special fixture being required for closing it.

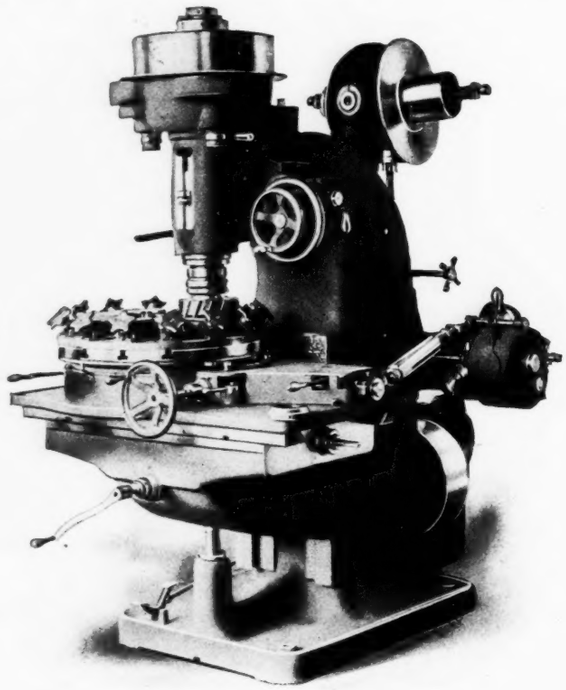
With this die, threads can be cut close to a shoulder,

and as the shank is hollow, any length of thread within the range of the turret slide travel, may be cut. The features claimed for this die are simplicity, accuracy, and durability. No small parts are applied externally where they are liable to be broken, and the die cannot be rendered inoperative by any chips or dirt which might get into the working parts. This type of die is made in seven sizes. The smallest has a capacity of ⅜ inch and the largest 2 inches.

BECKER CONTINUOUS CIRCULAR MILLING MACHINE

A special circular milling machine designed for continuous operation and built by the Becker Milling Machine Co., Hyde Park, Mass., is illustrated herewith. The table of this machine has a longitudinal feeding movement instead of a transverse adjustment to and from the operator, so that the machine can be used to advantage for surface milling in a straight line, as well as on strictly rotary work, which the machine is specially intended for.

The machine illustrated is fitted with a milling fixture for holding sad-irons. This fixture has a capacity for fourteen castings, and is mounted on a circular table 30 inches in diameter. The table makes one revolution in from three to four minutes, when doing this particular work, which gives the operator sufficient time to remove the finished castings, clean



Special Circular Milling Machine for Continuous Operation, built by Becker Milling Machine Co.

out the chips and insert rough castings while the machine is running, so that the milling operation is continuous. Two or three thousand pieces per day can be finished when the continuous method of milling is employed, the quantity depending on the character of the material.

When milling ordinary soft cast iron with a high-speed steel inserted-tooth surface mill, 7½ inches in diameter, the table may be rotated at the rate of one revolution in three minutes with the spindle running sixty revolutions per minute, the drive being by an open belt with all the spindle gears out of mesh. When doing work of a heavier nature and when milling steel, the back-gears probably would be required, though this machine is designed to handle, satisfactorily, the average line of work without employing the spindle gears.

The spindle driving pulley is 20 inches in diameter and a 5-inch double belt is used, which gives a powerful drive. The open belt capacity is sufficient to take cuts, varying from 1/16 inch to 3/32 inch deep in cast iron with the table feeding 8 inches per minute and using surface mills 10 to 12 inches in diameter, and much heavier cuts can be taken when smaller mills are used. Therefore, under ordinary conditions, the back-gears are not necessary, and when these are thrown out, no gears are in mesh. The ratios of the spindle back-gears are 3 to 1, and 8 to 1. When using the 8 to 1 gears, the milling capacity is equal to the removal of 25 cubic inches of cast iron per minute.

JACQUES DIAMOND-POINT LATHE TOOL

The Jacques diamond-point lathe tool embodies in a single drop-forged piece, a succession of points which are used one after another as the end points are ground away. By referring to the illustration, it will be seen that these points are formed by V-shaped indentations in the sides of the tool, thus combining twelve tools in one. The points thus formed in each half are

Lathe Tool having Twelve Points, which are used successively

so spaced that when one point has been used up by grinding, another, on the opposite side, is exposed for use. This new point is then sharpened and hardened in the usual way. The economy of the tool lies, of course, in the fact that no blacksmithing is required in re-pointing.

This tool is manufactured by the Billings & Spencer Co., of Hartford, Conn. The first of these tools made was hardened throughout in order to do away with the necessity of re-tempering each point, but it was found that a fully hardened tool, when subjected to heavy strains, would break in the center. Therefore the tool, as now furnished, has only the two end points hardened, the middle portion being of normal temper to increase the strength. This tool is drop-forged from the best high-speed tool steel.

WELLS BROS. SERIAL TAPS

When a "blind" hole, or one that is closed at the bottom, is tapped with ordinary machinists' hand taps, the usual practice is to first use the taper tap which is followed by the plug and bottoming taps, providing the thread is to extend to the bottom of the hole. As these three taps are the same size and differ only in the number of cutting teeth, the taper tap does practically all the work and leaves very little metal to be cut by the plug and bottoming taps, which simply form

Wells Bros. Serial Taps, which are proportioned to more evenly distribute the Work of Tapping

threads at the bottom of the hole. The result is that the taper tap is either worn out sooner than the others in the same set, or is broken, because it does most of the work of tapping.

The Wells Bros. Co., Greenfield, Mass., has recently begun the manufacture of an improved line of taps designed to distribute the work of tapping a hole more equally along the three taps of the set. These are known as "serial" taps and are so named because they are made in a series of 1, 2 and 3. Unlike the ordinary hand taps, only tap No. 3 cuts the nominal size, so that the No. 1 tap does much less work because it is

considerably smaller than the No. 3 size, in both outside and pitch diameters. The No. 2 tap more closely approaches the size of the No. 3, but it is also under-sized. The second tap of the set, however, enlarges the hole so that the No. 3 tap merely removes a few thousandths of an inch of material and finishes the thread to the exact size. The distribution of the work among the three taps is as follows: No. 1 takes 54 per cent of the cut, No. 2, 30 per cent, and No. 3, only 16 per cent. In order that any tap of the set may be picked out easily, even though covered with oil, there are rings on the shanks which shows the tap's number.

A special machine was constructed for recording the amount of power required to drive these taps, in order to proportion them correctly. Results of some of the tests are as follows: The power required for a No. 1 serial tap was 53 per cent of that necessary for an old-style tap, whereas the No. 2 serial tap required 49 per cent, and the No. 3 serial tap, 26 per cent. It was also found that the serial taps, when properly proportioned, have a factor of safety of 7, whereas an ordinary plug tap may have only a factor of safety of 2.

These serial taps are particularly desirable for tapping wrought iron, steel, and all tough material in which the service is severe. As is well known, a large proportion of the ordinary hand taps break instead of wearing out, and, naturally, by giving each tap a proportionate amount of work, a considerable reduction in breakage will result.

The serial taps are made to meet particular needs. If the set is to be used for tapping through open holes, each tap is tapered five or six threads, but if the threads must extend to the bottom of a hole, then the No. 1 tap is tapered six threads, the No. 2 is tapered four threads, and the No. 3 tap, two threads.

ADVANCE MACHINE TOOL CO.'S 18-INCH DRILL

The drilling machine illustrated herewith is built by the Advance Machine Tool Co., Milwaukee, Wis. The machine is equipped with an exceptionally large table and is especially adapted for tool-room work. The table arm is arranged so that the table can be removed and replaced by any platen, thus making a very convenient arrangement for jig work.

Eighteen-inch Drill Press built by Advance Machine Tool Co.

The spindle is counterweighted and has a ratchet lever feed, with a quick-return lever on the opposite side. The spindle has a vertical travel of 7½ inches, and the table a vertical movement on the column of 24 inches. The maximum distance from the spindle to the table is 28 inches, and the table can be swung out of the way to permit drilling on the base. The maximum distance from the base to the spindle is 39 inches. The spindle has a No. 2 Morse taper, a diameter of 1 1/16 inch, and an over-all length of 27 1/2 inches. The diameter of the sleeve is 1¾ inch. The cone pulley has four steps, the largest and smallest diameters of which are 8 inches and 3½ inches, respectively, with a width of 1¾ inch. The diameter of the tight and loose pulleys is 6 inches and the width 2¼ inches. This machine requires a floor space of 36 by 18 inches.

NORMA BALL AND ROLLER BEARINGS

The Norma ball and roller bearings have been on the European market for some years, but they are just being introduced in this country by the Norma Company of America, 20 Vesey St., New York.

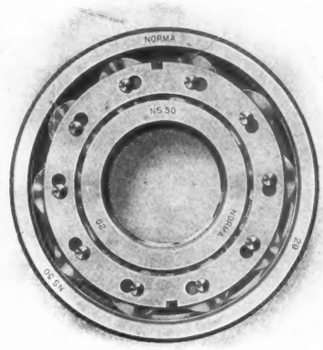


Fig. 1. Norma Roller Bearing

The Norma roller bearing is an open type, the outer races being open-sided so that the bearings can be taken apart, thus enabling the races to be separately fitted and mounted. The short cylindrical rollers are held and guided in a steel cage, as indicated in Fig. 1, and they are secured against skewing, binding or exerting any axial pressure on their side guides. The roller track of the outer race is slightly convex and the inner race is cylindrical. Both of these races are rigidly fastened in place when the bearings are installed. It is claimed that the efficiency or action of the bearing is not affected by axial displacement of the shaft, by small errors in mounting, or by any vibration or jarring motion which may occur. These roller bearings will carry more than twice the radial load of ball bearings of the same dimensions, and in the new construction, weight and space can often be saved by using roller bearings in place of ball bearings. The roller bearings are supplied for medium or heavy service. They are not intended to take end thrust, and in installations where a thrust occurs a combination roller and ball thrust bearing, or the Norma thrust bearing in combination, is recommended.

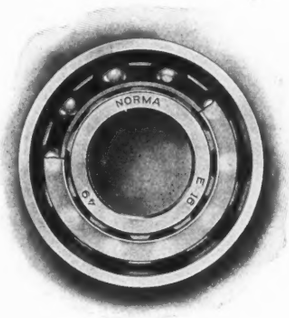


Fig. 2. Norma Ball Bearing

The Norma annular ball bearing, which is illustrated in Fig. 2, is also an open type, the outer race being open on one side so that the bearing can be taken apart. The members of this bearing can be mounted independently of each other, and all parts are interchangeable. These features facilitate the fitting and assembling of the bearing and its surrounding details. The outer race with the open side permits a convenient mounting in undivided housings, either free of play or with an allowance for lateral movement. The outer and inner races, however, are always held rigidly. The ball cage yieldingly grips and guides the balls at their axes of rotation and holds them free from contact with the apertures in the cage, thus insuring a free rotation of the balls, an almost entire absence of friction, and silent operation. These bearings are supplied in all the usual dimensions and for

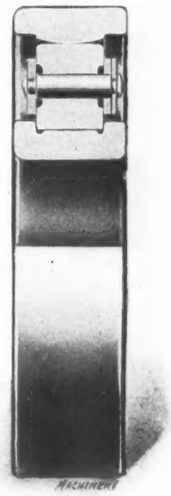


Fig. 3. Sectional View of Norma Roller Bearing

light, medium or heavy service. Both the ball and roller bearings are manufactured by the Norma Company of Cannstatt, Stuttgart, Germany. They are made of the best materials and finished to a high degree of accuracy.

GENERAL ELECTRIC CLOTH PINIONS

The General Electric Co., Schenectady, N. Y., is now applying cloth pinions to gear transmissions, where, because of noise or for other reasons, the meshing of metallic pinions with metallic gears would be impracticable or undesirable. The advantages claimed for these pinions are, great tooth strength, noiseless operation, freedom from damage by exposure to dampness, dryness or temperature changes, elasticity of the teeth sufficient to absorb shocks liable to break cast iron or brass pinions, self-lubrication, and long life.

Several different styles of these pinions are shown in Figs. 1, 2 and 3 of the accompanying illustrations. The blanks from which these pinions are formed, consist, essentially, of a filler of cotton or similar material, which is confined at a pressure of several tons to the square inch between steel shrouds or side-plates, which are held together by threaded rivets, or, in the case of very small pinions, by threaded sleeves. The teeth are cut to the 14½-degree involute system according to Brown & Sharpe's standard. After the teeth are cut, the cloth filler is impregnated with oil and it is entirely impervious to moisture and unaffected by atmospheric changes. It is also proof against injury by vermin.

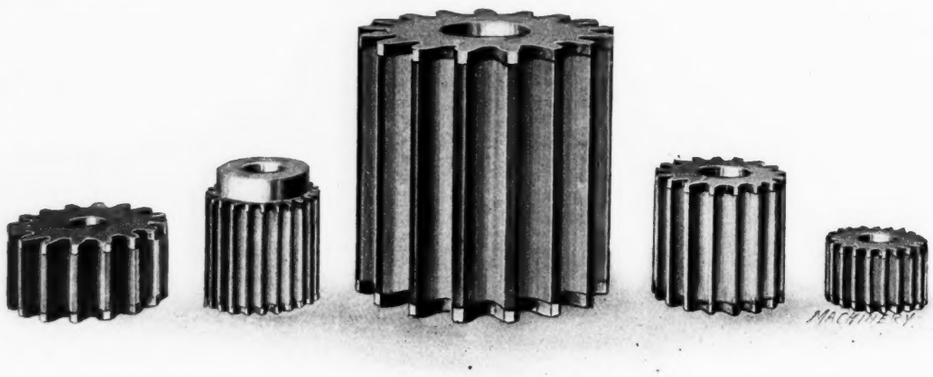


Fig. 1. Cloth Pinions developed by the General Electric Co.

The strength of these cloth pinions is said to be equal to that of any other non-metallic gearing and, as a slight elasticity gives the meshing teeth a good bearing across the full width of the face and absorbs the shock of rapid torque variations, it is claimed that these gears can safely be used for practically any service within the limit of the strength of similar cast-iron gears. While these pinions are ordinarily furnished for the smaller members of gear trains, they are made in a wide variety of forms including a type of gear of large diameter, consisting of a spider having a cloth-filled rim. The thickness of the shroud varies somewhat with the diameter and pitch, but, in general, it is approximately equal in thickness to the teeth at the pitch line. The width of the cloth face should be equal to the width of the companion gear, plus the total end play of both shafts, so that the shroud will not come in contact with the meshing gear.

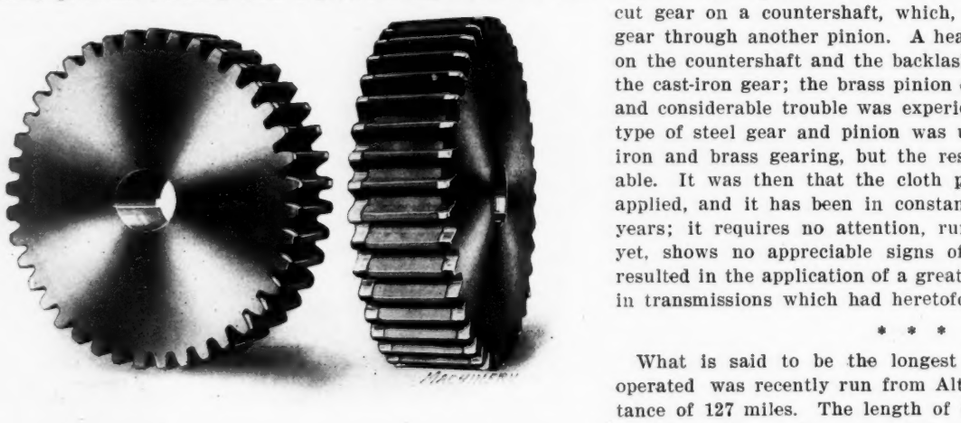


Fig. 2. Forty-tooth Four-pitch Cloth Pinions used on Battleship "Kearsarge"

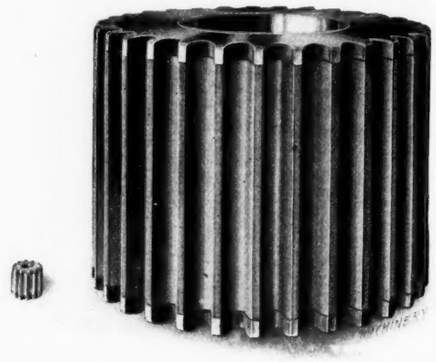


Fig. 3. Large and Small Cloth Pinions. Large Size has Thirty-one Teeth of 2 Pitch, and Small Size Twelve Teeth of 10 Pitch

These cloth pinions are intended for application to shop tools, such as lathes, planers, traveling cranes, drill presses, shears, punches, etc., and they are specially recommended for motor-driven tools. These pinions are also applicable to the driving of looms and spinning frames for the heavy machinery of paper and pulp mills, gas engine ignition drives and timing-gear trains, etc.

The invention of the cloth pinion was the result of a search for a pinion to successfully operate the combined punch and shear used in the General Electric Co.'s forge shop. This machine was originally fitted with a train of gears consisting of a brass pinion on the motor shaft, driving a cast-iron cut gear on a countershaft, which, in turn, drove the main gear through another pinion. A heavy flywheel was mounted on the countershaft and the backlash stripped the teeth from the cast-iron gear; the brass pinion also rapidly lost its shape and considerable trouble was experienced. At first a railway type of steel gear and pinion was used in place of the cast-iron and brass gearing, but the resulting noise was intolerable. It was then that the cloth pinion was conceived and applied, and it has been in constant operation for over two years; it requires no attention, runs without noise and, as yet, shows no appreciable signs of wear. This experience resulted in the application of a great many other cloth pinions in transmissions which had heretofore given trouble.

* * *

What is said to be the longest and heaviest train ever operated was recently run from Altoona to Enola, Pa., a distance of 127 miles. The length of the train was 4888 feet—nearly a mile—and it consisted of 120 steel gondola cars loaded with 6450 tons of coal. It was pulled at the rate of thirteen miles an hour by a single locomotive of the type known as "H-8-B." The engine was connected with the caboose by telephone. The train was run as a test to determine the capacity of freight locomotives over the improved sections of the line, where grades have been removed and curves compensated.

NEW MACHINERY AND TOOLS NOTES

Side-Tool: Ready Tool Co., Bridgeport, Conn. Offset side-tool especially made for facing close to a shoulder or to the chuck of a lathe. The cutter is rigidly supported, and it can be given clearance both on the side and front by grinding one face only. Common sizes of flat steel, such as 5/8 inch by 1/8 inch, or 7/8 inch by 3/16 inch, are used for cutters in these holders, or by means of an adjusting screw, thinner stock may be employed.

Crank Shaper: Ohio Machine Tool Co., Kenton, O. Shapers built in four sizes with strokes varying from 16 to 24 inches and having single and back-gears. The 18-inch single-geared machine has speed variations for the ram ranging from 16 to 70 per minute, whereas the back-geared shaper of the same size has changes varying from 7 to 115 strokes per minute. Adjustments of the ram for position and stroke may be made while the machine is in motion.

Boring Machine: Newton Machine Tool Wks., Inc., Philadelphia, Pa. Horizontal double-spindle boring machine designed especially for boring two single automobile cylinders or one twin cylinder, simultaneously. The spindles are driven by a three-step cone through intermediate spur gearing. The distance from the center of the spindle to the table is 8 inches, and the distance between the spindle centers is 5 inches. The work-table is 18 inches long and 20 inches wide. There is a feeding movement of 18 inches having two gear changes, an automatic release, and hand adjustment.

Tilting Vise: F. A. Schulz, 218 N. Jefferson St., Chicago, Ill. A quick-acting tilting vise for use on the drill press, shaper, or milling machine. This vise is adjustable to different angular positions, varying from 0 to 45 degrees, and it can often be used in place of a jig. The adjustment of the jaws is practically instantaneous, a clutch nut being provided which can be quickly released in order to give the screw a free longitudinal movement. In addition to the regular jaws, removable tool steel V-shaped jaws can also be supplied. This vise is built in three sizes with weights varying from 20 to 75 pounds.

Boring, Drilling and Milling Machine: Newton Machine Tool Wks., Inc., Philadelphia, Pa. Heavy portable boring, drilling and milling machine especially adapted for electrical works, locomotive plants and similar lines of manufacture. The maximum distance from the center of the spindle to the base of this machine is 68 inches; the diameter of the spindle is 5 inches, and the length of the feed, 32 inches. Power is supplied by a motor mounted on a pedestal in the rear, and the drive to the spindle can be either direct or through back-gears. The machine is equipped with facing arms of an improved type.

Drill Sockets: Corona Mfg. & Supply Co., 311. Atlantic Ave., Boston, Mass. Drill socket designed for holding reamers, milling cutters and different types of twist drills. The socket has extensions on either side which, in the case of a twist drill, come in direct contact with the sides of the flute, thus giving a powerful drive. Drills with broken tangs can be made to fit this form of socket by cutting the flute back to the shank at a depth corresponding to the diameter of the shank. Milling tools and reamers for this new socket are made with an engagement which comes against the projections on the socket.

Relieving Attachment: Bradford Machine Tool Co., Cincinnati, O. Improved design of Bradford relieving attachment for relieving straight or tapered work with any number of flutes varying from two to twenty-four, inclusive. All parts are self-contained in a substantial bracket, which is mounted on the headstock at the front of the lathe. The attachment is driven by a spur gear meshing with the spindle face gear. The amount of relief may be quickly and accurately adjusted without stopping the lathe. A set of change gears and an index plate are furnished providing from two to twenty-four movements per revolution of the spindle.

Air Drills: Cleveland Pneumatic Tool Co., Cleveland, O. Pneumatic air drill having four single-acting pistons arranged in pairs with each pair connected to opposite wrists of a double crankshaft. These drills are made in either reversible or non-reversible types. The crankshaft is mounted on annular ball bearings in place of plain bronze bearings, thus minimizing friction and wear. The air valve is a rotary duplex type driven through gearing. It is placed between each vertical set of cylinders and controls the admission of air to all four pistons, thus simplifying the construction. The pistons are secured to their connecting-rods by ball-and-socket joints to allow universal motion and adjustment for wear.

Combination Grinder: Challenge Machine Co., Inc., 5116 Springfield Ave., Philadelphia, Pa. Combination grinding machine so designed that the table can be placed above or below the wheel to accommodate work which can be ground better with the wheel above or below, as the case may be. When the table is placed over the wheel, the latter operates through a slot. If dies or other pieces are to be ground that can be handled to better advantage by passing them under the wheel, a plain table or one without a wheel slot is used. The machine has two wheels, one of which can be equipped with a plain work-rest or a water arrangement for wet tool grinding, so that there are practically three machines in one. This grinder is built in four sizes and can be furnished for either bench or floor use.

Comptometer: Felt & Tarrant Mfg. Co., 1713 N. Paulina St., Chicago, Ill. New type of comptometer for use in drafting-rooms, containing two columns of keys for the addition of inches and fractions of inches in eighths. This feature enables the machine to be used for checking detail dimensions with over-all lengths in constructional plans, and is particularly useful where measurements involve feet, inches and fractions of inches. Such dimensions are added by merely pressing the keys corresponding to each whole number and fraction, in feet and inches, so that the operation is purely mechanical and entirely automatic as far as computation is concerned. In case two or more keys are struck simultaneously, no error results, and it is possible with a little practice to depress from four to eight keys at a time, the only restriction being that no two shall be in the same vertical column. This machine is also adapted to other forms of calculation common to engineering practice and general accounting.

Ball Bearing Ring and Plug Gages: New Departure Mfg. Co., Bristol, Conn. A set of ring and plug gages made by this company to demonstrate the merits of the straight chamfer for the inner races of ball bearings, in comparison with races having a rounded corner. This set consists of six rings and an equal number of plugs. The plugs represent the shafts for three standard sizes of bearings and show the various fillets recommended by several bearing manufacturers for use in the respective sizes. The rings correspond to the inner races or bearing cones and each ring shows two methods of finishing the corners of the cones to correspond with the plugs. A portion of the rings is cut away so that the fitting or relation of the chamfer or radius (as the case may be) to the fillet on the shaft can easily be observed. The advantage claimed for the straight chamfer is that it can be more easily machined and clears the shaft fillet more readily than does the round corner, thus insuring a good bearing of the cone against the shaft shoulder.

* * *

DISK GRINDING NOT A SECRET

We quote the following from the *Gardner Grinder*, a house organ issued by the Gardner Machine Co., Beloit, Wis., as being a good editorial on the futility of secretiveness in machining methods:

"There is no secret or mystery in modern disk grinding or disk grinding processes. If your competitor is at all alive, he knows—or can if he wants to—whether or not you operate a disk grinder.

"Time was, however, when the first disk grinders were installed that their owners did not want anyone else to know there was such a tool on the market. They guarded their disk grinder with envious eyes for fear their competitors might learn of this labor-saving tool.

"But that time has passed. Trade papers, advertising, salesmen and all bearer of new 'thinks' make it impossible to keep the disk grinder hidden. It is needless to say we are doing our best to make it public property.

"This leads us to the question, 'Is it worth while to try to keep secret your methods of machining?' This has been tried—and is being tried to-day—by many manufacturers, but generally with little success. As long as your method requires you to employ help your secret is bound to leak out. Your employes are apt to leave you, either in good or bad graces, and with them goes your secret.

"Of course, this matter is the manufacturer's own business, but it has been demonstrated beyond doubt that those who invite visitors into their plant and show them how they do things are just as prosperous as those who do not. This latter type may be likened to an ostrich which buries only his head in the sand and thinks he is entirely under cover. If you have tools, methods and devices upon the exclusive use of which your success depends it would be far more satisfactory to have them patented."

* * *

Investigations have been made at the German official testing bureau for materials to ascertain to what extent repeated meltings of bearing metals influence their strength and reliability. As regards white metal (alloys of copper, antimony and tin) it was found that repeated meltings did not noticeably alter the grain, but that the rate of cooling had a considerable influence. Quick cooling yielded a finer grain and higher hardness and strength, and the investigators recommend that white metals should not be heated to high temperatures and that they should be cooled rapidly. Bronze, poor in tin, and, therefore, comparatively inexpensive, may have the hardness and strength increased by being rapidly cooled from a temperature of 1440 degrees F.

QUICK-RETURN MOTION OF THE STOCKBRIDGE SHAPER

A simple form of quick-return mechanism, which is sometimes applied to shapers, is shown diagrammatically in Fig. 1. This mechanism, which is well known, especially to designers of machine tools, consists, principally, of a crank-gear *G*, which is driven by a pinion and actuates a vibrating slotted link *L* that is connected at its upper end with the shaper ram. As the illustration shows, the crankpin or swiveling block *B*

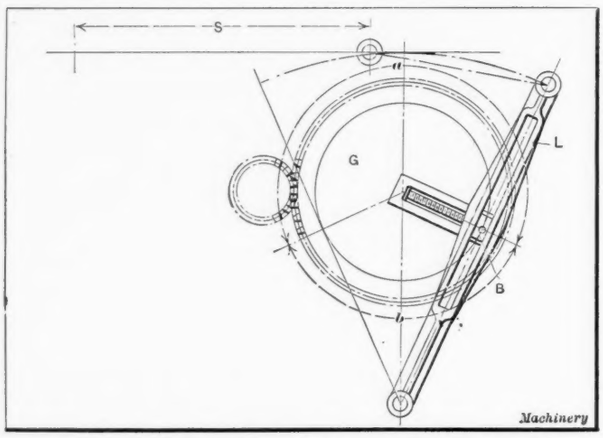


Fig. 1. View illustrating the Quick-return of a Plain Slotted Crank

(which slides in the slotted arm) moves through an arc *a* during the cutting stroke, whereas for the return stroke it moves through a much shorter arc *b*. As gear *G* rotates at a uniform speed, obviously the time required for the return stroke, as compared with the cutting stroke, is in the same proportion as the lengths of the arcs *a* and *b*. This mechanism is very simple, but it imparts a variable speed to the ram, the speed increasing toward the center of the stroke *S* and then diminishing, as will be explained more fully later.

Another quick-return motion that has been widely used in slotter construction is illustrated by the diagram Fig. 2. This mechanism, known as the Whitworth quick return, is similar in principle to the vibrating link previously referred to, though the construction is somewhat different. The gear *G* drives a slotted link *L*, which is pivoted at some point within the path of the crankpin or block *B*, thus permitting the link to rotate through a complete revolution. As the center about which link *L* rotates, is offset with relation to the center of the driving gear *G*, the driving pin *B* moves through an arc *a* during the cutting stroke, and through a shorter arc *b* for the return stroke, which, therefore, requires less time, in proportion to the respective lengths of arcs *a* and *b*.

Figs. 4 and 5 illustrate a quick-return mechanism that is a modification of the Whitworth motion combined with the

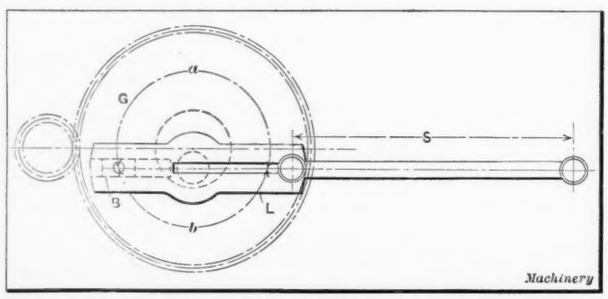


Fig. 2. Diagram illustrating Principle of Whitworth Quick-return Motion

slotted link. This motion is applied to the shapers built by the Stockbridge Machine Co., Worcester, Mass., and has the advantage of giving, not only a quick return, but a cutting speed that is practically constant throughout the working stroke; in addition, the construction is such that the stroke can be varied at will, while the machine is in motion.

The way the speed is gradually increased toward the center of the stroke and then diminished by a plain vibrating slotted link, is shown by the velocity curve *V*, Fig. 4. This curve was plotted by the well-known method of dividing the path of the driving crankpin (which rotates at a uniform speed) into a number of equal parts as shown. Lines were then drawn through points 0, 2, 4, 6, etc., thus locating on the line of motion *M—M* the respective positions 2, 4, 6, etc., of the ram for the different angular positions of the driving crank. All lines thus obtained by the divisions lying within arc *a* represent the movement of the ram on the forward stroke, and similar lines located with reference to divisions 50, 52, 54, etc., in arc *b*, show the movement for the return stroke. After these points are located on the line of motion, the velocity curve *V* can be plotted by drawing vertical ordinates 1, 3, 5, 7, etc., midway between points 0 and 2, 2 and 4, etc., and laying off on these vertical lines distances equal to the distance from 0 to 2, 2 to 4, etc. The velocity curve is then drawn through points obtained in this way, and it shows, graphically, the velocity of the ram at any point of the stroke, by its distance from the line of motion. It will be seen that the velocity gradually increases toward the center of the working stroke, then diminishes, and the ram returns to the starting point at a relatively high speed. Evidently this change of speed during the working stroke is objectionable.

The mechanism illustrated in Fig. 3 gives a uniform speed, as shown by the velocity curve V_1, Fig. 5. This curve, it will be noted, is flat, or an equal distance from the line of motion

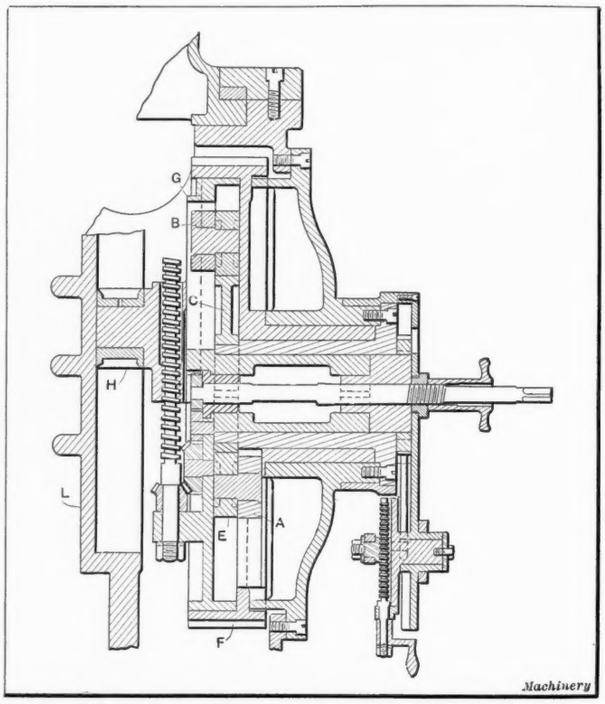


Fig. 3. Sectional View of Crank Mechanism applied to Stockbridge Shapers

from *C* to *D*, or for practically the entire working stroke, whereas the speed, as shown by curve *V*, gradually increases up to point *A* and diminishes after passing point *B*. As these curves are drawn to a very small scale, a slight change in the vertical distance from the horizontal line indicates a considerable change in speed. For example, if the height *x* represents a speed of 50 feet per minute, the slight fall of the curve at *y* would mean a reduction of about 8 feet per minute. Therefore the difference in action, as represented by curves *V* and V_1, is greater than is apparent from a casual inspection.

The mechanism for obtaining the constant cutting speed and quick return shown by curve V_1 consists principally of a driving gear *F*, Fig. 3, which transmits its rotary movement through a swiveling block *A* to a ring *E*, which turns about an eccentric *C*. On the opposite side of this ring there is a second swiveling block *B*, which drives the crank-disk *G*, on which is mounted the main crankpin block *H*, engaging the vibrating arm or link *L*, that in turn, is connected with the ram. The eccentric *C* is offset with relation to the center of the driving gear *F*, and it remains permanently in a fixed position; therefore the circular path of the eccentric ring blocks *A* and *B* is not concentric with the path described

by the main crankpin H, as shown in Fig. 5. In other words, the circle which these blocks describe as they are driven around by gear F, has a constantly varying radius from the center of the gear which compensates for the irregularity of speed obtained by a plain slotted link, and gives a practically constant movement during the working stroke.

The action of the mechanism will doubtless be made clearer by considering the method of plotting the velocity curve (Fig. 5), previously referred to. The large outer circle representing the driving gear, is divided into a number of equal parts indicating different positions of the gear which, it should be remembered, rotates at a uniform speed. The position of the swivel block A, (see Fig. 3), is first located for positions 2, 4, etc., of the gear, by the intersection of radial lines with the circle described by block A. For example, when the driving gear has moved an angular distance arc d during the cutting stroke, whereas the return stroke is accomplished while the gear moves through the comparatively short arc c. The positions of the slotted arm at the beginning, center, and end of the cutting stroke are shown in Figs. 6, 7 and 8, respectively, and also the respective positions of eccentric ring E, through which crank-disk G is driven. From the beginning to the end of the cutting stroke, blocks A and B move through an angle of approximately 270 degrees, so that a movement of only 90 degrees is required for the return stroke, thus giving a ratio of 3 to 1. This ratio, however, is as high as 4 to 1 on some sizes of the Stockbridge shapers, and it also varies somewhat with the length of the stroke, the ratio diminishing as the stroke is reduced. The ratio of the return to the cutting speed, obtained by the mechanism illustrated in Fig. 3, is much higher than that obtained with a plain slotted crank, as

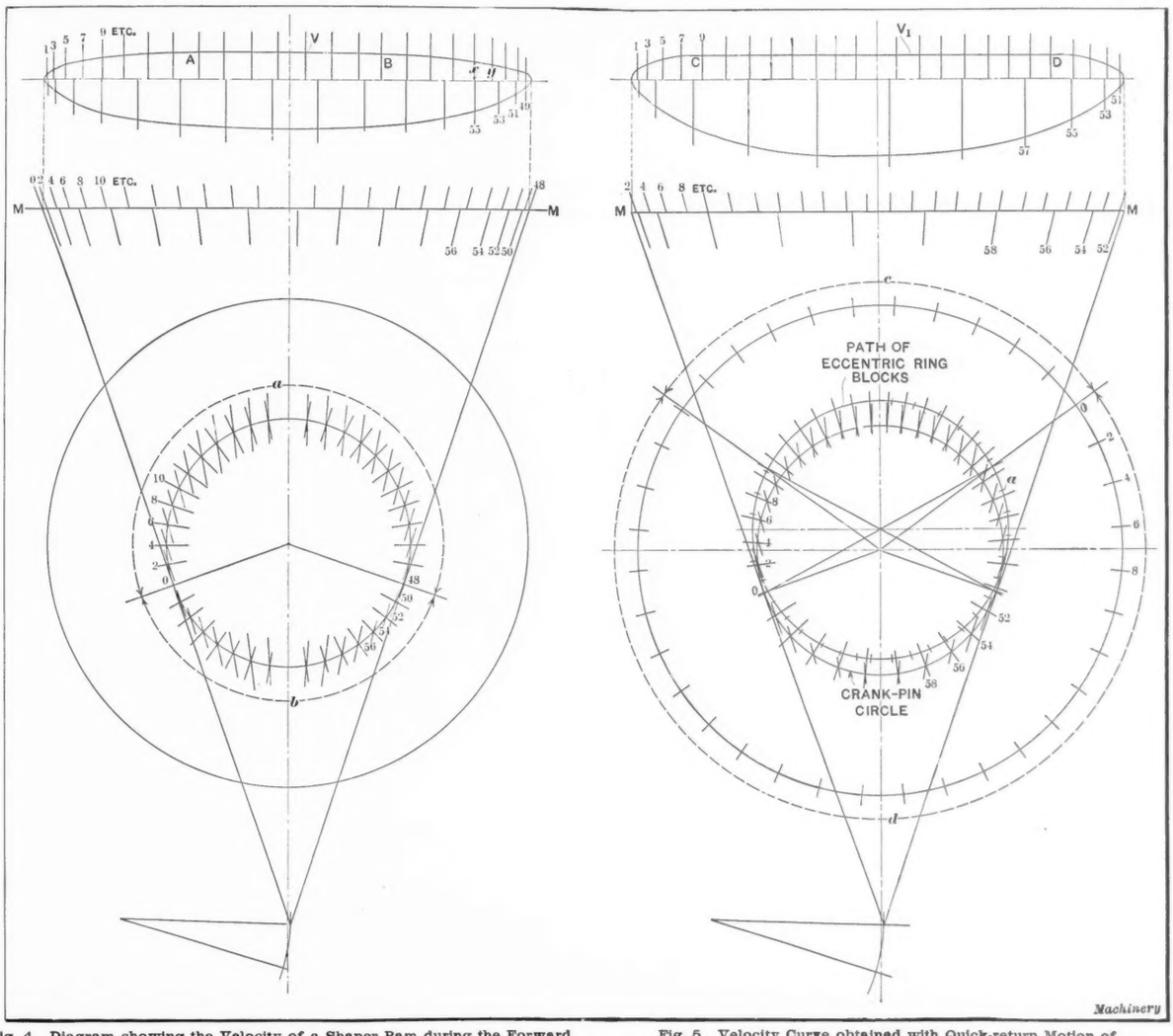


Fig. 4. Diagram showing the Velocity of a Shaper Ram during the Forward and Return Strokes when driven by a Plain Slotted Crank

Fig. 5. Velocity Curve obtained with Quick-return Motion of Stockbridge Shapers

0—2, block A will have moved to position a in the eccentric circle. As block B is diametrically opposite block A, its position is located for point 2 by drawing a line through the center of the eccentric circle. The next step is to determine the location of the main crank-block H for the different positions of block B. As crank H revolves about the center of the gear and is diametrically opposite block B, its location is determined by the intersection of radial lines with the crank-pin circle, the lines being drawn from the center of gear A and through the different points occupied by block B. After having located these points on the crankpin circle, the position of the ram for each respective division is found by drawing a line representing the slotted arm, through each point, 2, 4, etc. The velocity curve is then plotted as described, in connection with Fig. 1.

With this mechanism the driving gear rotates through an shown by the diagrams Figs. 4 and 5. In Fig. 4 the arc a through which the crankpin moves during the cutting stroke is, of course, equal to the angular movement of the driving gear as both revolve together about a common center. In the case of Fig. 5, however, the driving gear, instead of rotating through an arc equal to that described by the crankpin during the cutting stroke, turns through about three-fourths of a revolution, or a greater angular distance. The result is that a comparatively short angular movement c returns the ram, and greater power is obtained for the working stroke. (The comparative results of power tests made with the regular crank motion and the Stockbridge motion were previously published in the November, 1909, number of MACHINERY.) The ratio of the return to the cutting stroke with a plain crank depends entirely on the relation of the rocker arm to the crank-block circle. The ratio diminishes

rapidly as the stroke is shortened, whereas with the motion illustrated in Fig. 5, the change of ratio is small, even for very short strokes.

Another method of plotting the velocity curve, which shows not only the speed at different points of the stroke, but also the relative time required for the forward and return movements, is shown in Fig. 9. In this illustration, a number of vertical ordinates 1, 3, 5, etc., representing positions mid-

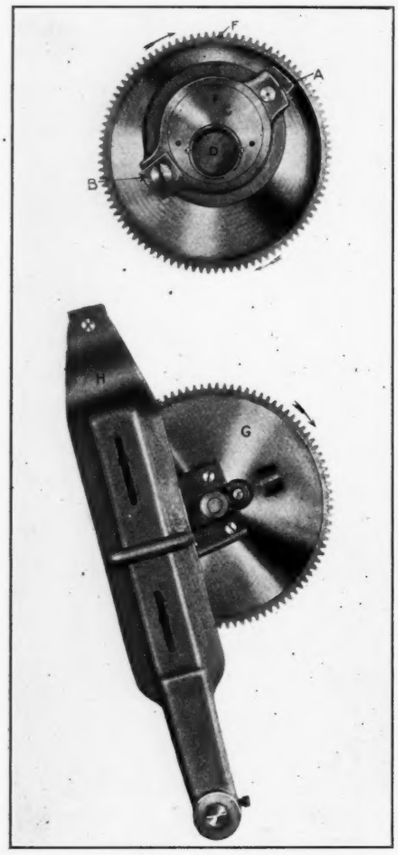


Fig. 6. Crank at Beginning of Cutting Stroke

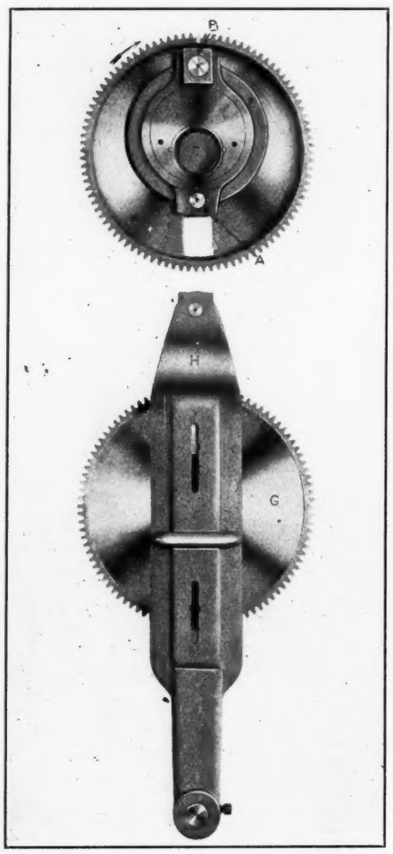


Fig. 7. Center of the Cutting Stroke

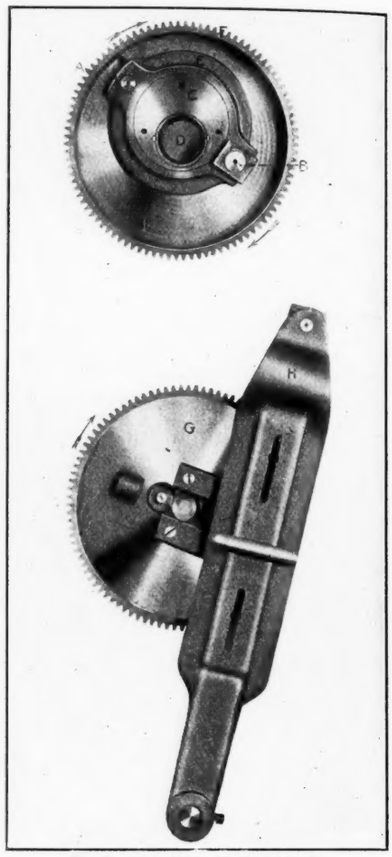


Fig. 8. End of the Cutting Stroke

way between positions 0 and 2, 2 and 4, etc. (Fig. 5), of the driving gear, have been drawn at right angles to a horizontal line x—x. The curve is then plotted by laying off on these lines distances representing the different positions of the ram. For example, a vertical distance is laid off on line 1 equal to the movement 0—2 of the ram, a point is located on line 3 corresponding to movement 2—4, etc. After all the positions of the ram on the forward stroke have been transferred to the vertical lines, corresponding points are laid off below the line of motion to represent the return stroke. A curve is then drawn through these various points, as shown. This curve by its distance above and below the line of motion shows, graphically, the relative velocity of the ram for the working and return strokes, and the distances a and b indicate the time required for these movements.

SEASONING HARDENED STEEL

It is a well-known fact that hardened pieces of steel will undergo minute but measurable changes in form during a long period of time after the hardening has taken place. These changes are due to the internal stresses produced by the hardening process, which are only slowly and gradually relieved. In order to eliminate the unfavorable results of these changes, gages and other tools of which a high degree of accuracy is required, are permitted to "season" for several months—or even a year—before they are finally ground and lapped to the finished dimensions. Experiments undertaken by A. Leman and A. Werner at the *Physikalisch-Technischen Reichanstalt*, and recorded in the August, 1911, number of *Werkstattstechnik*, indicate that changes in the dimensions of hardened steel take place sometimes during a period as long as three years. In order to find a method of overcoming the delay due to "seasoning" hardened steel for so long a time, experiments were undertaken which proved very successful. The investigators found that by heating the hardened steel in oil at a temperature of 150 degrees C. (302 degrees F.) for a period of ten hours, the internal stresses which cause changes, were eliminated.

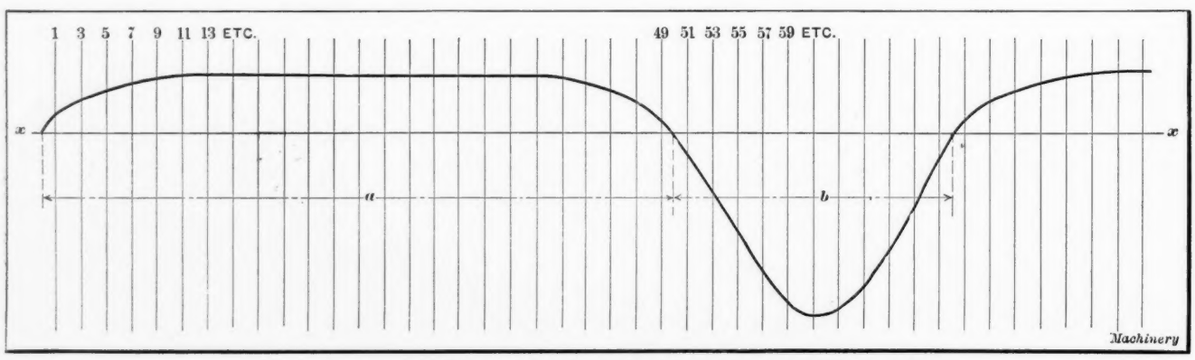


Fig. 9. Curve showing Velocity during Forward and Return Strokes and Time required

ROTARY MAGAZINE WORK ON THE CLEVELAND AUTOMATIC

The phosphor-bronze shell shown in Fig. 1 is an interesting example of automatic turret machine work, owing to the number of operations that must be performed and the remarkably

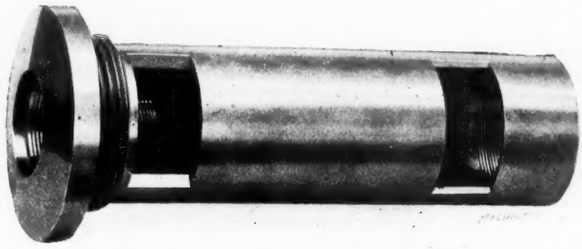


Fig. 1. Hard Phosphor-bronze Shell turned complete in Nine Minutes

short time required, the total time per piece being about nine minutes. The over-all length of this shell, which is shown on a reduced scale, is 6½ inches, the maximum diameter, 2⅝ inches, and it must be finished accurately to gage. This work is done on the automatic turret machine built by the Cleveland Automatic Machine Co., a 2¼-inch machine increased to 2⅝ inches being used.

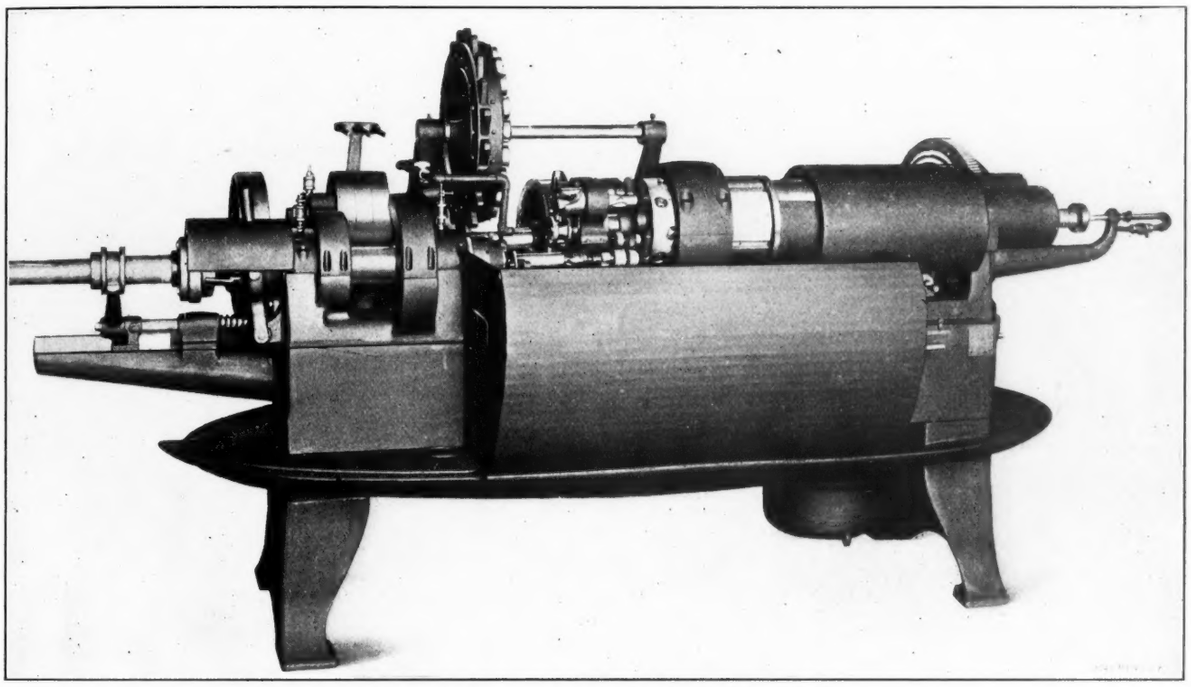


Fig. 2. Cleveland Automatic set up for Turning Shell shown in Fig. 1

As Fig. 1 indicates, these shells are rough- and finish-turned on the outside from the solid bar and bored, counterbored and reamed on the inside; stud is formed and threaded at the bottom of the bore; the right end is threaded internally; a coarse thread is cut close to the flange, as shown; the latter is rounded, and the left end is drilled, counterbored and threaded internally. Only two separate operations are required for doing the work specified, the shell being first machined from the bar and then finished in a second operation, which requires the use of the rotary magazine attachment. The various steps or phases of each operation are indicated in Fig. 4, the letters *A* to *F*, inclusive, showing the work done during the first operation, and the three detail views *G*, *H* and *I*, the successive steps of the second operation.

The first step of Operation 1 is to gage the stock to length as at *A*. The work is then rough-turned at *a* (see sketch *B*) by a hollow mill held in a special overhanging tool-holder, and hole *b* is drilled. The shoulder *d*, which is subsequently threaded, is also formed, and surface *e* is rounded, as shown, this work being done by flat forming tools mounted on the rear of the cross-slide and with the spindle running reversed. The time required for the work indicated at *B* is two minutes, fifty seconds.

The third operation in connection with the first complete operation consists in finishing surface *a* (sketch *C*) by using a special shaving mill held in an overhanging tool-holder, reaming and counterboring hole *f* and forming stud *c*. This stud is formed by a hollow cutting end of the counterbore. The spindle rotates backward while the tools are in operation, but it is given a forward motion as the tools back off to prevent the shaving mill cutter from marking the finish of surface *a*. The time for the third operation is two minutes, thirty seconds.

The thread is next cut on shoulder *d* with a special die-holder and finger die, which requires thirty seconds. During the fifth operation a thread is tapped at *g* in the end of the bore *f*, and a thread is also cut on stud *c*. A special combination tap and die is used to perform both threading operations simultaneously. The tap and die are fitted together in such a way that they can be adjusted.

The sixth and last step connected with the first operation is to part the shell from the bar, which is done by a circular cut-off tool mounted on the front of the cross-slide. An idle movement requiring thirty-five seconds then follows, giving a total time of seven minutes, thirty-five seconds.

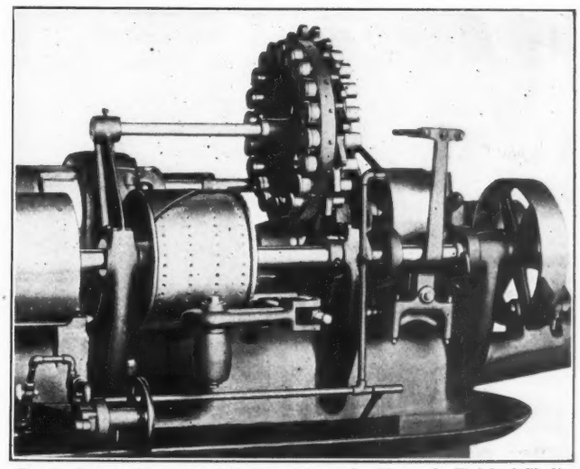


Fig. 3. Rotary Magazine Attachment loaded with Partly Finished Shells

The rotary magazine used in connection with the second operation is shown loaded in Fig. 3. This magazine is fitted

with bushings that are bored to receive the body *a* of the shell, and after the first operation, the work is placed in these bushings in practically the same way that cartridges are inserted in a revolver chamber. The magazine is very simple in construction, and it can be loaded by a boy; in fact, one boy can attend to several machines if necessary.

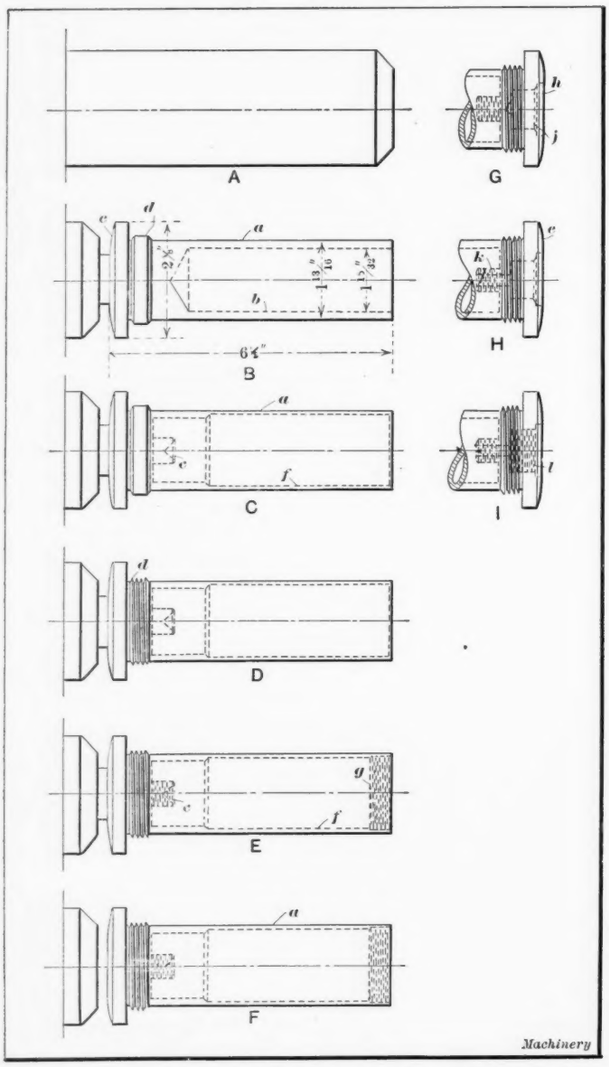


Fig. 4. Successive Steps of First and Second Operations performed on Shell, Fig. 1

During the second operation the shells are removed from the magazine and inserted in the chuck by a conveyor attached to the turret. The first step in the second operation is indicated at *G*. It consists of drilling and counterboring at *j* and *h* and spotting or centering the bottom of *j* for a small hole *k* that is drilled in the succeeding operation. A special combined drill, counterbore and centering tool is used, and the spindle runs reversed. The time required is thirty-five seconds. The high-speed drilling attachment is then used to drill hole *k* (sketch *H*) and a light shaving cut is taken over surface *e* with a flat forming tool mounted on the rear of the cross-slide. The spindle also runs reversed for the second step, and the time is twenty seconds. The third and last step of the second operation is to tap thread *l*, which requires thirty seconds. There is then an idle period of thirty-five seconds, making a total of nine minutes, thirty-five seconds for finishing the shell complete, which is a remarkable performance, especially when we consider that these shells are made from very hard phosphor-bronze. The stock removed during both operations weighs 9⅜ pounds and the weight of a finished shell is 1¾ pound.

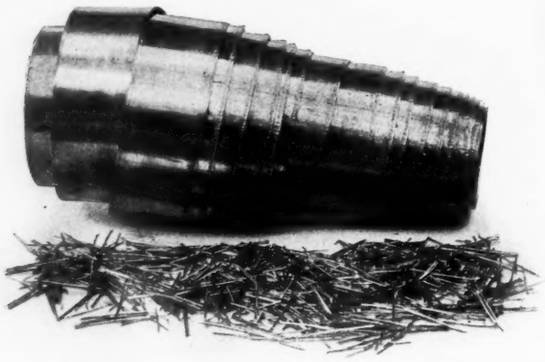


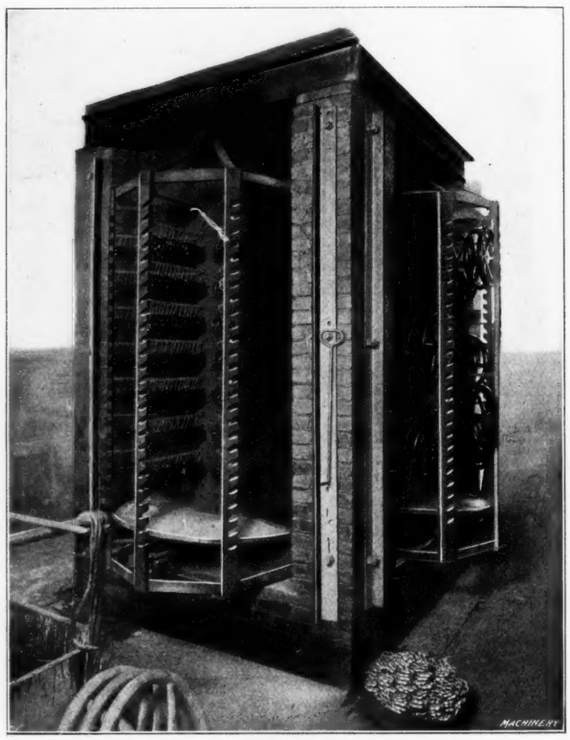
Fig. 5. Showing Change in Formation of Chips removed from Bars made by Different Formulas

In Fig. 5 some chips are shown merely to illustrate the great change in the formation of chips removed from phosphor-bronze bars made by different formulas. In one case the chips are in the form of long flat ribbons, and in the other, the tool removed very fine cuttings which are no larger than a common pin. Of course the same tool was used in each case and the chips were removed from corresponding surfaces.

* * *

JAPANNING OVEN

A japanning oven for continuous operation was recently developed by Mr. Mason, vice-president and manager of the Nelson Valve Co., Philadelphia, Pa., in conjunction with Mr. George K. Hooper, of the Hooper-Falkenau Engineering Co., New York. This oven consists of three reels mounted in a substantial brick casing; two of these reels may be seen in the accompanying illustration. They are so located that one half of each is always inside the oven, while the other half projects beyond the oven casing. Each is built up on a central pipe which is perforated to receive rods or bars resting in slotted vertical outer ribs. Upon these bars are hung the articles to be japanned. The reel is divided vertically by a sheet metal diaphragm which serves to close the oven, confining one-half of the reel within the heated space.



Japanning Oven

To operate this oven, the articles dipped are hung upon the racks of that half of the reel which is outside the oven. The reel is then revolved half a turn, which moves the pieces into the heated space; at the same time the other half of the reel containing the pieces which have been baked, is brought out-

side the oven. When the baked pieces are removed, that half of the reel outside the oven is ready to be filled with freshly dipped pieces as previously described. This operation is continuous, involves a very low labor cost, and great elasticity is provided for, because various types of pieces to be baked can be kept in the oven the proper length of time for each.

* * *

TOOL TEMPERING FURNACE

A tool tempering furnace which can be built with about one hundred standard fire-bricks on any tool temperer's forge is shown in Figs. 1 and 2. The advantages of the type of fire obtained with this furnace, as compared with the ordinary forge fire, are, that it gives the three most important qualities of a good tempering fire: First, a deep permanent fire; second, an intensely hot fire, when wanted; and third, a fire in which it is possible to get a very short heat on a tool, the high heat extending only to the cutting edge or nose of the tool.

As shown in the sectional view, the fire is deep below the nose of the tool, and does not burn out, as new fuel constantly works down from the hopper. This insures a good heat continuously, so that tool after tool, or two or three at a time, may be tempered at a high heat without placing them in contact with the coals. To prevent the fire from burning back into the hopper, a piece of sheet iron or asbestos is laid over the top, as indicated in Fig. 1.

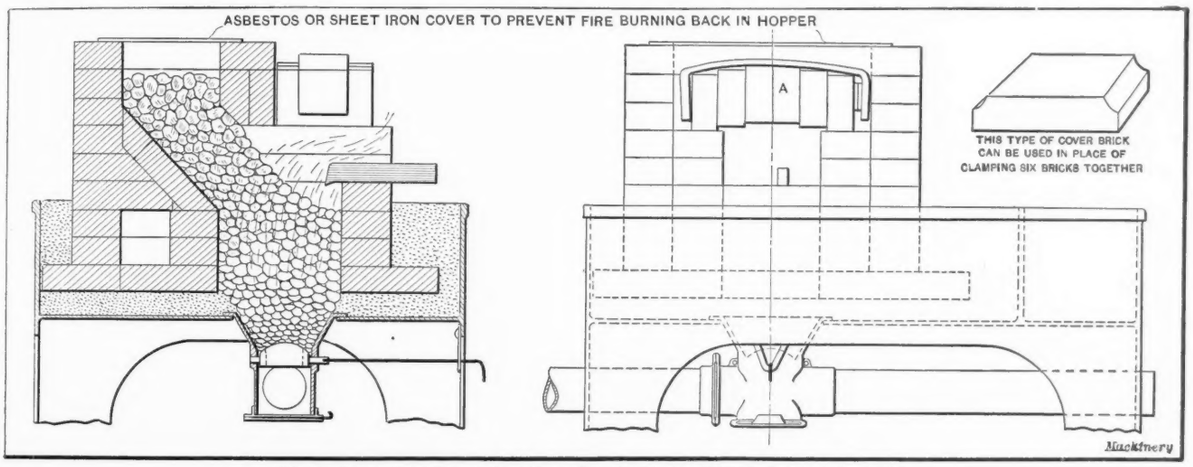

ASBESTOS OR SHEET IRON COVER TO PREVENT FIRE BURNING BACK IN HOPPER
A
THIS TYPE OF COVER BRICK CAN BE USED IN PLACE OF CLAMPING SIX BRICKS TOGETHER
Machinery

Fig. 1. Section and Front Elevation of Tool-tempering Furnace built of Fire-brick

By resting the tool on a firebrick with the cutting edge down, a heat is obtained just where it is wanted, that is on the cutting edge, and at the same time the heat is confined to the nose of the tool. For fuel, either coke or hard coal may be used to advantage. The furnace is cleaned out the same as a forge.

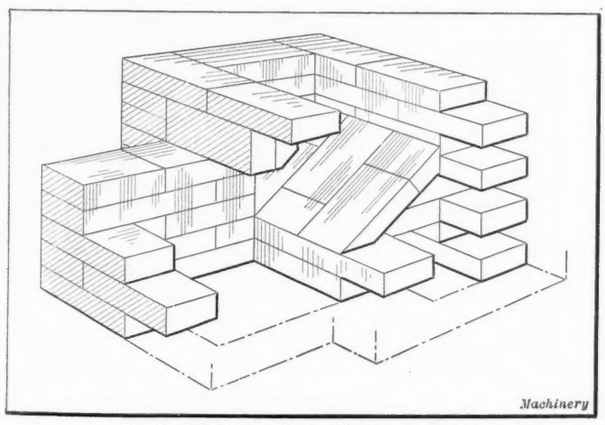


Fig. 2. Perspective View of Tempering Furnace

The construction of the furnace requires no special bricks or foundation other than a blacksmith's forge. The six bricks *A*, clamped together as a "top brick", should be removable, so that they can be taken off when a tool of special shape requires it.

This type of furnace has been worked out by the tempering department of the Firth-Sterling Steel Co., Pittsburg, for the benefit of customers using its Blue Chip steel; but it is, of course, equally useful in the treatment of any high-speed steel. Neither the furnace nor the material used in its construction are sold by this company. This type of furnace is said to be very effective in aiding the man at the fire to produce better and more uniform tools.

* * *

THE WENTWORTH INSTITUTE

The Wentworth Institute, a new industrial school of a practical type, was opened in Boston on September 25. The school is the result of a bequest by Arioch Wentworth of Boston, who by his will made $3,500,000 available for a school whose purpose it should be "to furnish education in the mechanical arts."

The Wentworth Institute is located on Huntington Ave., directly opposite the new Museum of Fine Arts, and occupies a plot of ground of between twelve and thirteen acres. The aim of the school is primarily to train young men to become foremen and superintendents in building construction and manufacturing industries, but a course is also included for young men who want to acquire some practical skill in the trades, so as to be able to enter them with a good earning power from the start. That there is a demand for a school of this kind in Boston is evidenced by the fact that eight- or nine-hundred students had registered at the time the school opened. Most of the applicants are young men between seventeen and twenty-eight years of age. Most of these have been engaged in some comparatively unskilled occupation, and finding the opportunities for advancement slow and uncertain, have turned to the institute in order to obtain instruction of such a practical character that it could be immediately used in obtaining a higher grade of employment. As it is only the shops belonging to large corporations that are able to maintain up-to-date apprenticeship systems, the value of a school of this type cannot be questioned.

It is proposed to keep the students at the Wentworth Institute one half of the day in the shop, while the other half of the day will be devoted to actual class-room instruction. The buildings so far completed are only a part of the ultimate plan for the school. The foundry and main shop building now ready is 145 feet long by 49 feet wide. This building is five stories high, and contains the carpenter shop, pattern shop, machine shop, blacksmith shop, plumbing shop and electric-wiring room. A small wing contains the administrative offices. The power plant occupies a building 80 feet square. The shops are equipped with the very best makes of modern tools and apparatus; for example, in the machine shop there are two high-grade horizontal boring machines, two different types of vertical boring mills of the best make, three milling machines, of which one is of the heavy-duty type, two modern grinding machines, etc. In all cases it has been the effort of the administration to include different types of machines, and also examples of the best makes of each type. In engine lathes,

for example, the four most prominent makers of machines of this kind are represented. In this respect, the institute differs largely from the ordinary trade school, where frequently a single type of small inexpensive machines is installed. The student then has no opportunity to become familiar with the machines ordinarily found in the machine shops throughout the country, and while he may learn the principles, he cannot gain that familiarity with machine tools which is a very valuable asset to him.

The power-house installation consists of a 230-horsepower water-tube boiler, a simple Corliss-type steam engine, and a 300 K. W., 220 volt, direct-current generator. The engine-room also contains the dynamo laboratory, consisting of a group of direct- and alternating-current generators, motors, transformers and testing apparatus. The tremendous increase in the application of electric motors to the driving of shop tools, and of electric power to locomotives and automobiles, makes it necessary that every skilled workman in almost any trade should have at least a slight acquaintance with electric generating and power machinery, so that he may have a sense of what is reasonable or unreasonable to expect of any given machine, and know how to recognize and remedy simple troubles in the electrical machinery he uses or is responsible for. The electrician must, in addition, be given further instruction so as to be able to trace and remedy troubles and faults in electrical machinery, and to carry out all such work in connection with installation, wiring, and testing, as may be required in the ordinary shop.

The institute will provide both day and evening courses. The day courses are of two types, a one-year course, and a more thorough two-year course. The one-year course is intended to prepare the student for ordinary practical industrial work, while the two-year course is intended for the young men who wish to obtain advanced positions. The graduates from this course will be prepared to fill positions as inspectors, testers, foremen, etc.

The large endowment fund left by Mr. Wentworth does not necessitate the payment of a tuition fee. However, if no fee at all were charged, some might apply who have little or no real interest in the work. For this reason, fees amounting to six dollars per term for day students, and six dollars per year for evening students, are charged. A very important adjunct to the work of the institute is found in the employment bureau officially maintained. It is considered that in a school of this type the securing of satisfactory employment for the students is one of the important functions of the work.

Great care has been exercised in selecting the instructors. The principal is Arthur Williston, who was at the head of the School of Science and Technology at the Pratt Institute in Brooklyn, N. Y., for twelve years. Mr. Williston is a graduate of the Massachusetts Institute of Technology. He has had experience as an engineer on one of the great western railroads and was a member of the commission which established the Carnegie Technical School in Pittsburg. He was also formerly a member of the faculty of the Ohio State University. The growth of the Pratt Institute under his direction has been very rapid, and his selection as principal will, no doubt, be found to be very advantageous for the Wentworth Institute.

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Joseph A. Barraja Frauenfelder, a German, was arrested September 21 for communicating knowledge of the construction of United States submarine vessels to Henry Harrison Suplee in New York, publisher of *Cassier's Magazine*. Frauenfelder will be prosecuted under the Act of Congress, March 3, 1911, providing penalties for disclosing knowledge of defenses without permission of authority. The indictment charges that Frauenfelder communicated a story with drawings descriptive of the construction of a submarine boat built by the Electric Boat Co.

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WASTE IN LUBRICATION

"Cylinder oils," says Arthur D. Little, "generally cost about what the user is accustomed to pay. Plants which employ a chemist pay from 19 to 27 cents. Manufacturers who do not need a chemist commonly pay 45 cents, 65 cents, or even, if they know their own business very well, $1.50 a gallon! There is probably not a large plant in the country in which if it is not already under chemical control, the lubrication account cannot be cut in two. In an engine room of one large cement plant the average monthly cost for lubricants had been $337. It is now $30. A concern paying 37 cents a pound for a special grease which the superintendent needed to run the mill now buys on specification for 5½ and the mill still runs. Another company within our knowledge saves $12,000 a year on cutting oils alone."

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PERSONALS

A. H. Teuchter, president of the Cincinnati-Bickford Tool Co., Cincinnati, Ohio, returned from a three months' European trip the latter part of August.

E. R. Euston, vice-president of the Stoever Foundry & Mfg. Co., Myerstown, Pa., who has been in charge of the company's New York office for the past ten years, will remove to its new plant at Easton, Pa., October 2.

Louis Parent, engineer with Fenwick Freres & Co., Paris, France, is in the United States on a two and one-half months' trip in the interests of his concern. His headquarters are Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

Crocker-Wheeler Co., Ampere, N. J., announces the resignation of Mr. Gano Dunn, who for a great many years has filled the position of chief engineer and first vice-president in the Crocker-Wheeler Co., with conspicuous ability. He leaves with the very best wishes of the company and his many friends and associates in it, for his future success.

W. Bonsor, recently associated with the Packard Motor Car Co., is now connected with the Stevens-Duryea Co. in the production department of the factory in the capacity of supervisor of parts. Mr. Bonsor's manufacturing experience has been rather extensive, and for some years he was connected with the Daimler Motor Co., Ltd., of Coventry, England.

Benjamin T. Delafield, who formerly represented the Lunkenheimer Co. for a number of years in the St. Louis and Kansas City territory, has become connected with the Best Mfg. Co., Pittsburg, Pa., to handle its line of valves, fittings, flanges, pipe bends, fabricated pipe and other power plant material in the same territory. He will make his headquarters in Kansas City.

Arthur E. Meyer, assistant and secretary to the general manager of the Toledo Machine & Tool Co., Toledo, Ohio, has resigned to become traveling representative for the Acklin Stamping Co., Toledo, Ohio. Mr. Meyer is the author of the articles on power presses and sheet-metal working machinery, appearing lately in MACHINERY under the nom-de-plume of "Hart Preston."

Chester L. Lucas, author of many valuable articles published in MACHINERY during the past four years, has joined the editorial staff. Mr. Lucas is an expert toolmaker and diemaker, having acquired much valuable experience with some of the best known concerns in New England. He will contribute articles on various phases of the metal-working industries, especially those that are comparatively little known outside of a narrow field.

Charles H. Jumper, chemical engineer of Arthur D. Little, Inc., chemists and engineers, Boston, Mass., will act as assistant to D. T. Randall in the centralized testing department which has recently been organized under Mr. Randall's direction by the above-mentioned concern. Mr. Jumper has had several years' experience in both the chemical and engineering divisions of the company from which he is detailed. This was preceded by service in the testing departments of the Pennsylvania and Union Pacific Railroads.

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OBITUARIES

Franklin B. Shuster, president and treasurer of the F. B. Shuster Co., New Haven, Conn., died of bronchial asthma at his home in New Haven, August 14, aged forty-five years.

Elias Burwell, a pioneer clockmaker, died in Bristol, Conn., September 2, aged nearly one hundred and one years. He invented the calendar clock, and for a long time was its exclusive manufacturer.

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COMING EVENTS

October 2-3.—Autumn meeting of the Iron & Steel Institute at Turin, Italy. G. C. Lloyd, secretary, 28 Victoria St., London, S. W., England.

October 2-28.—Industrial and educational exposition under the auspices of the Boston Chamber of Commerce, held in the Mechanics' Building at Boston, Mass. This exposition is devoted strictly to New England industries. No manufacturer outside of New England will be allowed to exhibit.

October 9-13.—Convention of the American Electric Railway Association, Young's New Pier, Atlantic City, N. J. H. C. Donecker, secretary-treasurer, 29 West 39th St., New York.

October 10.—MACHINERY's ninth annual entertainment, Hotel Astor, New York, Tuesday evening at 8 o'clock.

October 10-12.—Tenth annual convention of the National Machine Tool Builders' Association, in New York City. Charles E. Hildreth, 134 Gold St., Worcester, Mass., secretary.

Oct. 12-14.—Tuck School conference on scientific management at